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MAIN REPORT

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WATER AND RELATED LAND RESOURCES
RIO GRANDE BASIN
COLORADO

A Report Based on a Cooperative Study by

COLORADO WATER CONSERVATION BOARD

and

UNITED STATES DEPARTMENT OF AGRICULTURE

PREPARED BY

ECONOMICS, STATISTICS, AND COOPERATIVES SERVICE, FOREST SERVICE, SOIL CONSERVATION SERVICE.

DENVER, COLORADO - SEPTEMBER 1978

USDA-SCS-PORTLAND, OR. 1978

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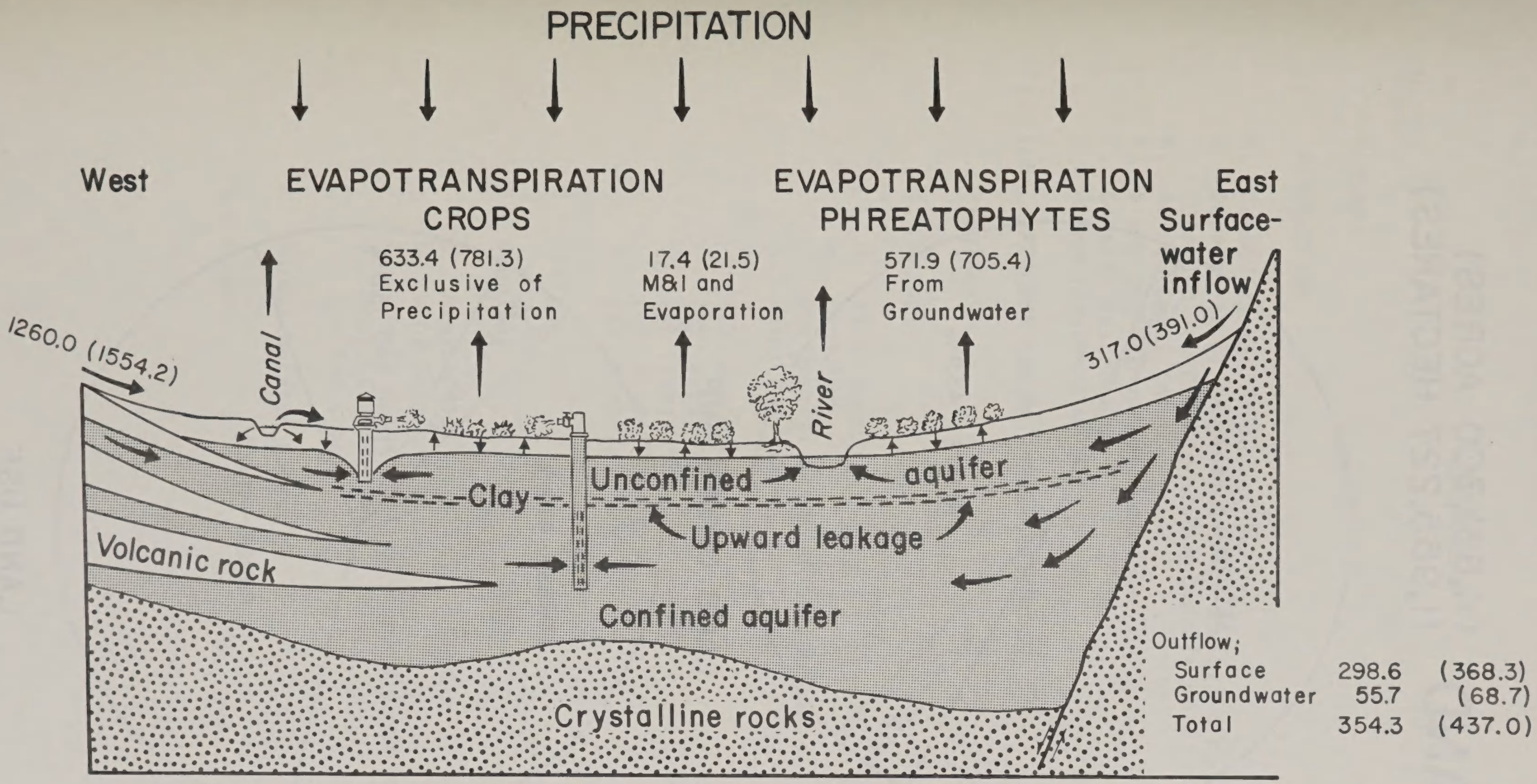

DIAGRAMMATIC SECTION

SAN LUIS VALLEY COLORADO

WATER BUDGET- 1000 Ac. Ft. (MILLION METRE^3)
FOR
Average Annual Water Supply (1924-69)
Approx. 1970 Level of Depletion

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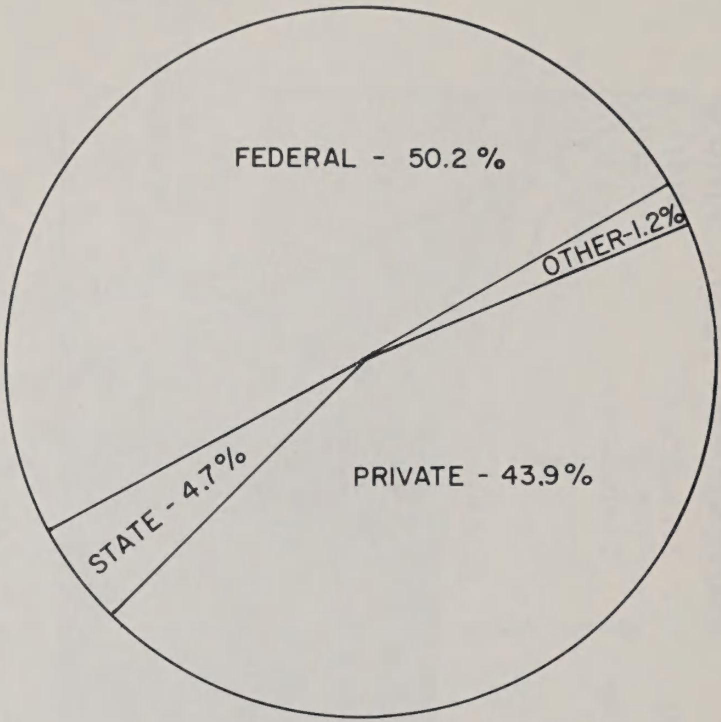
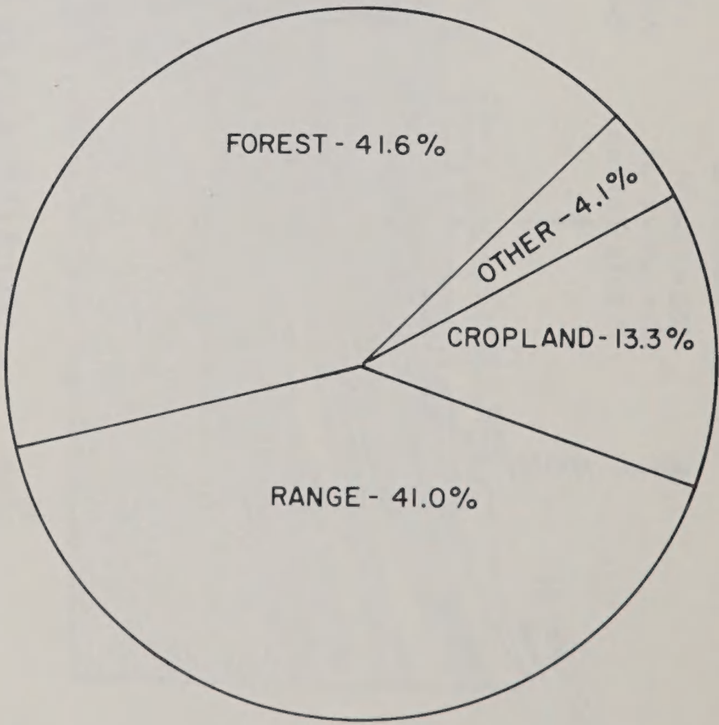
LAND (4,831,300 ACRES) (1,955,227 HECTARES)



LAND OWNERSHIP



LAND USE

FRONTISPIECE 2

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SUMMARY

CHAPTER I -- SUMMARY

Purpose of Study and Agencies Involved

This study of the water and related land resources in the Rio Grande Basin was made under Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended). Agencies of the U.S. Department of Agriculture (USDA) with direct responsibilities in the study are the Soil Conservation Service, Economic Statistics Cooperatives Service and the Forest Service. The Colorado Water Conservation Board represents the State and coordinates the study. The work of these agencies is directed by a Field Advisory Committee composed of one representative from each agency.

The overall purpose of the study is to improve the quality of life of the basin's residents through contributions to national economic development and environmental quality objectives.

This report is to be provided to federal, state and local interest for use as a guide to conserving, developing and utilizing their water and related land resources in an efficient and timely manner. It will serve as an aid to decision-makers in choosing among alternatives or competing uses of resources.

The study area includes only that portion of the Rio Grande Basin found in Colorado. This is the entire headwaters of the river. The Rio Grande Basin in Colorado encompasses about 5 million acres (2,023,500 ha) in south central Colorado and is bounded on the west and north by the Continental Divide, on the east by the Sangre de Cristo Range, and on the south by the Colorado-New Mexico state line. (See Plate 1, Location Map).

Problems

The identified water and related land resource problems were divided into national economic development and environmental quality groups and then further divided into specific study components. The national economic development problems identified by state and local publics are as follows: inadequate water for late season irrigation (including inadequate storage facilities), over appropriation of streamflow, withdrawals for Rio Grande Compact, inefficient irrigation and delivery systems, inadequate drainage, annual spring flooding, low inherent fertility and organic matter, wind erosion, noxious weed control, limited range of crops, inadequate rural electrification, underdeveloped range resources and overgrazing, inadequate sanitation, inadequate municipal water supply, poor housing, lack of recreational areas and facilities, inadequate recreational access, insufficient timber supply to operate existing mills at capacity, current level of timber management will not allow basin's resources to contribute their share of

nation's future needs, significant mortality in overmature and significant stagnation in immature stands, and fluctuating under and over utilization of recreation resources. The environmental quality problems were identified as follows: wind erosion, lack of recreation areas and facilities, water pollution is being caused by mine drainage and agriculture runoff, opportunities for scientific investigation and recreation in a wilderness setting may be significantly diminished, decreasing big game winter range, big game migration routes are threatened by urban development, inadequate access to public land for hunting and fishing purposes, degradation of trout habitat due to siltation of streams by road construction and timber harvest activities, survival of endangered and threatened wildlife species is in jeopardy, and smoke from sawmill burners degrades air quality.

Needs

Components needed to meet objectives of the study have been identified. These components will contribute to either national economic development or environmental quality or both. Generally, these needs are as follows:

National Economic Development

Increased or more efficient output of food and fiber.

Increased supply of electric energy to San Luis Valley.

Increased and/or more efficient output of livestock products.

Reduced sanitary hazards.

Increased municipal water supply.

Increased low cost housing.

Increased recreational facilities.

Increased recreational access.

Increased or more efficient output of forest products.

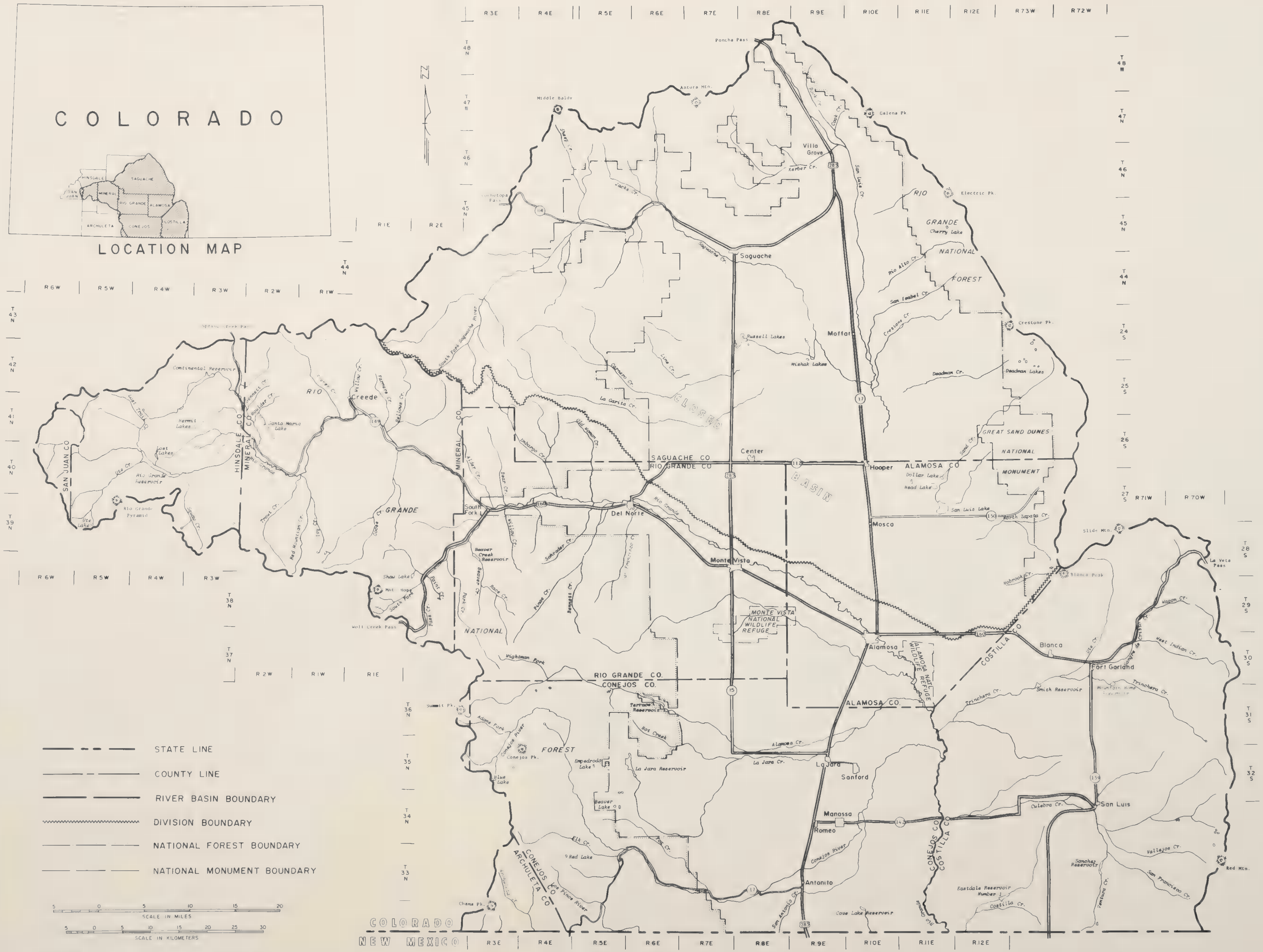
More efficient output of recreation opportunities.

Environmental Quality

Preservation and management of the land resource base.

Preserve the quality aspects of water, land and air.

Enhancement of quality aspects of water.



LOCATION
RIO GRANDE BASIN
COLORADO
1978

PLATE I

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

CHAPTER III
LOCAL PROBLEMS AND NATIONAL OBJECTIVES

National Objective	Problems (Public Concerns)	Components of the Objective: Desired Goods and Services	Components of the Objective: Preferred Resource Treatment
NED 1	Inadequate water for late season irrigation.	Increased or more efficient output of food and fiber.	Provide water for late season irrigation. Increase the quantity and improve the timing of water yield from forested land.
NED 2	Over appropriation of streamflow. Withdrawals for Rio Grande Compact.	"	Manage water allocation to assure compliance with Water Compact and seasonal water need.
NED 3	Inefficient irrigation and delivery system.	"	Improve physical irrigation systems and water scheduling.
NED 4	Inadequate drainage.	"	Drainage of agriculture land.
NED 5	Flooding.	"	Improve the timing of water yield from forested land. Provide reduction in flood damage.
NED 6	Low inherent fertility and organic matter.	"	Improve management and vegetative practices of farming operations.
NED 7	Wind erosion.	"	Promote improved vegetative and management practices.
NED 8	Noxious weed control.	"	Increase application of herbicides.
NED 9	Limited range of crops.	"	Introduce new crop varieties.

CHAPTER IV
RESOURCE BASE

RESOURCES

Irrigation Water Resources

Month	Surface Water 1/ Acre feet	(Million m3)	Acre Feet* Per Acre	m3/ha
April	104,350	128.7	0.171	521.7
May	366,050	451.5	0.600	1830.1
June	386,400	476.6	0.634	1931.9
July	197,100	243.1	0.323	985.4
August	126,300	155.8	0.207	631.5
September	81,000	99.9	0.133	404.0
Season	1,261,200	1,555.7	2.068	6305.5
Nonseason	174,800	215.6		

*Irrigated acres 609,600 (246,705 ha)
1/ At point of diversion

Socio-political structures at the state and local levels are the means for revising present statutes, and scrutinizing current concepts and attitudes for water allocation so as to eliminate overappropriation and fulfilling legal requirements of the Compact.

Irrigated Land and Water Delivery

Irrigation System	Acres	Hectares
Surface	582,090	235,572
Sprinkler	27,500	11,129
Total Irrigated Land	609,590	246,701

Agricultural Drainage Lands

	(Acres)	(Hectares)
With Drainage System	167,194	67,663
Without Drainage System	47,846	19,363
Total	215,040	87,026

Lands subject to flooding 328,600 acres, (132,984 ha). Communities subject to flooding 14.

Lands continuously denuded of vegetation without leaving residues or artificially applying humus and fertilizers will deteriorate in fertility and/or game matter. Socio-economic forces act on landowner attitudes regarding soil nutrient depletion.

Urban development subdivisions 3,336 acres, (1,350 ha).
Cropland subject to wind erosion -332,808 acres, (134,700 ha).
Potential windbreaks - total length - 330,480 feet, (133,745 ha).

Weed control is primarily a problem to agricultural lands. They may be noxious for crop production but beneficial for ground cover and wildlife habitat. Control is dependent on landowner attitudes.

Suitable crop production in the basin is largely a function of physiography and climate. Until strains or varieties of crops are produced which are not presently adaptable to the basin, the number and types of crops will be limited to those currently produced.

CHAPTER V
ECONOMIC PROJECTIONS AND ENVIRONMENTAL PREFERENCES

OBERS E' Basin Allocation - Crop Production

Food & Fiber	Unit	Year 1990	Year 2000	Year 2020
Oats	bu (m^3)	416,300 (14,670)	442,200 (15,583)	424,300 (14,952)
Spring Wheat	bu (m^3)	133,000 (4,687)	142,200 (5,011)	136,400 (4,807)
Winter Wheat	bu (m^3)	26,200 (923)	28,000 (987)	26,900 (948)
Barley Feed	bu (m^3)	694,800 (24,484)	737,400 (25,985)	707,500 (24,932)
Barley Malt	bu (m^3)	6,880,100 (242,443)	8,592,000 (302,774)	11,377,000 (413,534)
Hay Alfalfa	ton (t)	200,500 (181,854)	214,100 (194,189)	205,400 (186,298)
Hay Small Grain	ton (t)	10,700 (9,705)	11,400 (10,340)	11,000 (9,977)
Hay Grass	ton (t)	141,200 (28,068)	148,300 (134,508)	142,300 (129,066)
Potatoes	cwt (kg)	9,772,200 (443,266,992)	10,436,000 (473,376,960)	10,012,000 (454,144,320)
Vegetables	Ac (ha)	6,400 (2,590)	6,400 (2,590)	6,400 (2,590)
Idle Crops	Ac (ha)	32,900 (13,315)	32,900 (13,315)	32,900 (13,315)
Crop Failure	Ac (ha)	3,800 (1,538)	3,700 (1,497)	3,700 (1,497)
Minor Crops	Ac (ha)	2,100 (850)	2,100 (850)	2,100 (850)

Environmental preference is to: Eliminate any excessive wind erosion and water pollution; improve soil fertility; overall soil cover and organic matter; expand range of crops, reduce flood hazards.

CHAPTER VI
FUTURE WITHOUT PRODUCTION AND ENVIRONMENTAL CONDITIONS

Future Without-Crop Production Values

Food & Fiber	Unit	Year 1990	Year 2000	Year 2020
Oats	bu (m3)	416,300 (14,670)	442,200 (15,583)	424,300 (14,952)
Spring Wheat	bu (m3)	57,000 (2,009)	67,200 (2,368)	63,100 (2,224)
Winter Wheat	bu (m3)	12,000 (423)	12,000 (423)	10,100 (356)
Barley Feed	bu (m3)	694,800 (24,484)	737,400 (25,985)	707,500 (24,932)
Barley Malt	bu (m3)	6,459,500 (227,620)	7,964,400 (280,658)	9,945,500 (350,470)
Hay Alfalfa	ton (t)	100,500 (91,154)	114,100 (103,489)	95,400 (86,528)
Hay Small Grain	ton (t)	10,200 (9,251)	10,400 (9,433)	11,000 (9,977)
Hay Grass	ton (t)	101,200 (91,788	108,300 (98,228)	102,200 (92,695)
Potatoes	cwt (kg)	9,772,200 (433,266,992)	10,436,000 (473,376,960)	10,012,000 (454,144,320)
Vegetables	Ac (ha)	6,400 (2,590)	6,400 (2,590)	6,400 (2,590
Idle Crops	Ac (ha)	32,900 (13,315)	32,900 (13,315)	32,900 (13,315)
Crop Failure	Ac (ha)	3,700 (1,497)	3,700 (1,497)	3,700 (1,497)
Minor Crops	AC (ha)	2,100 (850)	2,100 (850)	2,100 (850)

Environmentally, there is no indication that positive action will be taken to reduce wind erosion, lessen pollution, and increase soil fertility, cover and organic matter; flood hazards will be reduced to some degree by ongoing projects, but no direct action taken. The range of crops will remain essentially the same as present.

REPORT CONTENTS OUTLINE
RIO GRANDE BASIN, COLORADO

CHAPTER VII
NEEDS - PROJECTED DEMANDS AND PREFERENCES NOT SATISFIED BY FUTURE WITHOUT PRODUCTION

Needs - Crop Production

Food and Fiber	Unit	Year [illegible]	Year [illegible]	Year 2020
Oats	bu (m3)	[illegible] ([illegible])	0 (0)	0 (0)
Spring Wheat	bu (m3)	76,000 (2,673)	75,000 (2,643)	73,300 (2,593)
Winter Wheat	bu (m3)	14,200 ([illegible])	16,000 (564)	16,800 (592)
Barley Feed	bu (m3)	0 (0)	0 (0)	0 (0)
Barley Malt	bu (m3)	4[illegible],800 (14,8[illegible])	627,800 (22,116)	1,931,510 (68,0[illegible])
Hay Alfalfa	ton (t)	100,000 ([illegible])	100,000 ([illegible])	[illegible] (99,770)
Hay Small Grain	ton (t)	500 (454)	1,000 (907)	0 (0)
Hay Grass	ton (t)	40,000 (36,2[illegible])	40,000 (36,280)	40,100 (36,371)
Potatoes	cwt (kg)	0 (0)	0 (0)	0 (0)
Vegetables	Ac (ha)	0 (0)	0 (0)	0 (0)
Idle Crops	Ac (ha)	0 (0)	0 (0)	0 (0)
Crop Failure	Ac (ha)	0 (0)	0 (0)	0 (0)
Minor Crops	Ac (ha)	0 (0)	0 (0)	0 (0)

Greater positive action is required to subdue wind erosion, water pollution and increase soil fertility, cover and organic matter. Intensive research is needed to investigate introduction of additional crops; accelerated flood control projects are necessary to reduce flood hazards. Revisions of water use and allocation procedures and legal aspects are required to alleviate overappropriation and continue to meet compact agreements. Local level government and agencies must be more aggressive in initiating action plans.

CHAPTER VIII
ALTERNATE PLANS

CHAPTER IX
OPPORTUNITIES FOR USDA PROGRAMS IN THE ALTERNATE PLAN

CHAPTER X
COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Effectiveness of Alternative Plans: National Economic Development	Alternate	Environmental Quality	USDA PROGRAMS	NON-USDA PROGRAMS
Increased total available irrigation water at the farm, which includes project and forest water yield. Month / Acre-feet / Million (m^3) April 7,300 9.0 May 65,100 80.3 June 66,600 82.2 July 28,600 35.3 August 21,400 26.4 September 13,900 17.2 Total 202,900 250.3	Same as NED	Provides for 2,000 acre-feet (2,467,000 m^3) of water for late season irrigation.	PL 83-566 - Watersheds PL 74-46 - Agricultural Conservation Program (ACP) PL 84-1021 - Great Plains Conservation Program (GPCP) PL 87-703 - Resource Conservation & Development Program (RC&D)	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Resources
By increasing water yield, alleviates some overappropriation and compact issues, but does nothing towards solution.	Same as NED	No significant effect.	None Available.	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Division of Water Resources Four Corners Regional Commission
Provides for: Leveling 4,700 acres land, [1,902 ha] Lining 176 miles [283 km] of ditch, Installing 2,300 control structures.	Same as NED	Includes limited diversion canals and irrigation water contro.	PL 83-566 - Watersheds PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Resources Bureau of Land Management Extension Service
Sum of all potential projects would drain 20,600 acres, [8,337 ha].	Same as NED	No effect.	PL 83-566 - Watersheds PL 74-46 - ACP PL 87-703 - RC&D	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Board of Land Commissioners Colorado Division of Water Resources Soil Conservation Districts Four Corners Regional Commission Corps of Engineers
All projects would provide control for 4 communities and 7,300 acres, [2,954 ha].	Same as NED	Provides flood control for 1 community and 2,000 acres, [809 ha].	PL 83-566 - Watersheds Flood Hazard Analyses PL 87-703 - RC&D	Corps of Engineers Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Resources Colorado Department of Local Affairs
Provide technical assistance to owners/operators for upgrading their soils.	Same as NED	Same as NED	PL 74-46 - ACP PL 84-1021 - GPCP Cooperative Forest Management Act of 1950	Bureau of Land Management Colorado State Board of Land Commissioners Coil Conservation Districts Extension Service
Promote management practices which have surface residues, establish windbreaks and maintain soil cover.	Same as NED	Same as NED	PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D (Urban Development)	Colorado State Forest Service Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Parks and Outdoor Recreation Colorado State Board of Land Commissioners Soil Conservation Districts Colorado Divisio of Wildlife Extension Service
Suggests establishing noxious plant & weed management districts to effectuate control without degrading environment.	Same as NED	Same as NED, but would limit control to non-wildlife habitat areas.	Science and Education Administration - Federal Research PL 74-46 - ACP PL 84-1021 - GPCP Administration of National Forest Land	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado State Board of Land Commissioners Colorado Division of Wildlife Soil Conservation Districts Four Corners Regional Commission Extension Service
Intensifies research to broaden range of crops adaptable to basin.	Same as NED	Same as NED as long as wildlife and nature plant patterns are not disrupted.	Science and Education Administration - Federal Research SCS-Plant Materials	Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Soil Conservation Districts Extension Service

TABLE 1-1
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RIO GRANDE BASIN, COLORADO

CHAPTER III
LOCAL PROBLEMS AND NATIONAL OBJECTIVES

CHAPTER IV
RESOURCE BASE

CHAPTER V
ECONOMIC PROJECTIONS AND
ENVIRONMENTAL PREFERENCES

CHAPTER VI
FUTURE WITHOUT PRODUCTION AND
ENVIRONMENTAL CONDITIONS

National Objective	Problems (Public Concerns)	Components of the Objective: Desired Goods and Services	Components of the Objective: Preferred Resource Treatment
NED 10	Inadequate rural electrification.	Increase supply of electric energy to San Luis Valley.	Increase high voltage electric lines serving valley.
NED 11	Underdeveloped range resources and over-grazing.	Increased and/or more efficient output of live-stock products.	Increase forage production.
NED 12	Inadequate sanitation.	Reduce sanitary hazards.	Improve sewage and solid waste disposal.
NED 13	Inadequate municipal water supply.	Increased municipal water supply.	Improve water storage and delivery.
NED 14	Poor housing.	Increased low cost housing.	Promote means for low cost housing.
NED 15	Lack of recreational areas and facilities.	Increased recreational facilities.	Provide more water, land and recreational facilities.
NED 16	Inadequate recreational access.	Increased recreational access.	Provide additional access to water and land for recreation.

Resources

NED 10

Chapter IV: The private industry responsible for providing rural electric energy is limited in its operational capability as to how rapid an area can be electrified.

Chapter V: Although population estimates show a moderate increase overall, this would only tend to aggravate these inadequacies in the future as demands for in all sectors increase.

Chapter VI: Plans show no rapid advancement for electrification beyond present rate, the need for transmission lines for pivot systems could increase; plans for upgrading sanitation systems have been completed, but whether implementation occurs is questionable; there is no indication that housing conditions will improve anymore rapidly in the future.

NED 11

Chapter IV:

Range Resources

Ownership Administrator	Acres	Hectares
U. S. Forest Service	981,572	397,241
Bureau of Land Management	495,991	200,728
U. S. Fish & Wildlife Service	23,342	9,447
State and Private	1,419,379	571,625
TOTAL	2,920,751	1,182,041

Chapter V:

OBERS E' Basin Allocation - Range and Pasture

Year	Animal Unit Months
1990	1,880,100
2000	2,092,600
2020	2,504,700

Chapter VI:

Future Without-Production for Range & Pasture

Year	Animal Unit Months
1990	1,655,100
2000	1,676,200
2020	1,732,000

NED 12

Chapter IV: Local government has already tackled this problem by developing plans for sewage and solid waste disposal.

Chapter V: See NED 10

Chapter VI: See NED 10

NED 13

Chapter IV: The water supply to communities in the basin is from wells. Of 25 communities 16 have either no existing system or have a need to enlarge and improve existing systems. Vast amounts of high quality ground water exists in the basin, so there is ample opportunity for additional water to meet projected needs.

Chapter V:

Demand for Municipal Water (16 Communities)

Year	Gallons	Liters
1980	7,615,000	28,825,421
2000	12,287,900	46,514,617

Chapter VI:

Future Without-No Expansion of Water Supply - 16 Communities

Year	Gallons	Liters
1980	7,287,300	27,963,886
2000	7,287,300	27,963,886

NED 14

Chapter IV: Resources to alleviate poor housing conditions consist of local government initiation of action for federal assistance through ongoing programs.

Chapter V: See NED 10

Chapter VI: See NED 10

NED 15

Chapter IV:

Developed Recreation Resources

Existing Developed Sites	Acres	Hectares	Inventoried Potential Sites	Acres	Hectares
Forest Svc	720 (a)	291	Forest Svc	5,455	2,208
Bureau of Land Mgmt.	0	0	Bureau of Land Mgmt.	40	16
State	834	338	State	0	0
Private	243	98	Private	200	81
Total Existing	1,797	727	Total Potential	5,695	2,305
National Park	36,816 (b)	15,626			

(a) Includes ski area
(b) Includes total NP area

Chapter V:

OBERS E' Basin Allocation - Developed Recreation

Thousand Visitor Days	Year 1980	Year 2020
Camping	336	1,053
Picnicking	167	463
Subtotal	503	1,516
National Park	79 (c)	79 (c)
Skiing	96 (c)	96 (c)
Total	599	1,612

(c) Remains constant

Environmentally, over-utilization of recreation resources should be eliminated, thereby reducing side degradation and allowing better management.

Chapter VI:

Future Without-Developed Recreation

Year	Thousand Visitor Days/Year
1990	1,555
2020	1,605

No change of direction is evident that working hours or vacation times will be altered to the extent necessary to appreciably affect utilization characteristics.

NED 16

Chapter IV: Many societal institutions must interact through their social-legal systems to develop rational means of obtaining right-of-way when access to these lands is not provided by conjunctive land management activities.

Chapter V: As demands for recreation resources increase, pressures to utilize presently inaccessible areas will also increase. Low cost and expeditious procurement of right-of-way to fully utilize all public recreational resources is economically preferred, while access systems should be developed only to the extent necessary to be compatible with resource use.

Chapter VI: Although some emphasis is being placed on obtaining right-of-ways more expeditiously, there is no evidence to show lower cost procurement or gaining access by means other than through land management activities related to these uses.

TABLE 1-1
REPORT CONTENTS OUTLINE
RIO GRANDE BASIN, COLORADO

CHAPTER VII NEEDS - PROJECTED DEMANDS AND PREFERENCES NOT SATISFIED BY FUTURE WITHOUT PRODUCTION	CHAPTER VIII ALTERNATE PLANS Effectiveness of Alternative Plans National Economic Development	 Alternate	 Environmental Quality	CHAPTER IX OPPORTUNITIES FOR USDA PROGRAMS IN THE ALTERNATE PLAN USDA PROGRAMS	CHAPTER X COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT NON-USDA PROGRAMS
Conflicts of jurisdiction for electrification must be resolved expeditiously so programs can be implemented as needs arise for irrigation and housing; since a sanitation plan exists, implementation is of the essence; a plan to provide adequate housing is paramount.	Provides for no new source of electric energy; advocates cooperation among responsible agencies for expeditious rural service to handle irrigation and housing needs.	Same as NED	Same as NED, except that all service facilities must be compatible with environment	Rural Electrification Administration (REA)	Bureau of Reclamation Corps of Engineers Colorado Department of Local Affairs Four Corners Regional Commission
Needs - Range and Pasture Production Year / Animal Unit Months 1990 / 225,000 2000 / 416,400 2020 / 772,700 Intensified range management practices need to be invoked.	Does not meet demand projections; capability of meeting demand is: Year / % of Demand 1990 / 82 2020 / 70	Same as NED, but capability of meeting demand is: Year / % of Demand 1990 / 81 2020 / 69	Same as NED, but capability of meeting demand is: Year / % of Demand 1990 / 76 2020 / 66	Administration of National Forest Land PL 74-46 - ACP	Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Soil Conservation District Extension Service
See Ch. 10	Advocates implementing completed sanitation plan for San Luis Valley.	Same as NED	Same as NED	Farmers Home Administration (FmHA)	Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Division of Local Affairs Four Corners Regional Commission
Needs - Water Supply - 16 Communities Year / Gallons / Liters 1980 / 327,720 / 1,240,476 2000 / 5,000,600 / 18,929,271	Considers extending water mains, constructing storage facilities, adding new wells and intake facilities.	Same as NED	Same as NED, plus must meet State Water Quality Standards.	(FmHA) PL 83-566 PL 87-703 - RC&D	Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Division of Water Resources Colorado Department of Local Affairs Four Corners Regional Commission
See Ch. 10	Backs strong initiative for promoting low cost housing by local governmental elements with assistance from state and federal agencies.	Same as NED	Same as NED	(FmHA)	Colorado Division of Water Quality Co Colorado State Board of Land Commissioners Colorado Department of Local Affairs Four Corners Regional Commission
Needs - Developed Recreation Year / Thousand Visitor Days/Year 1980 / 0 2020 / 7 More equal distribution of area and facility utilization is needed to prevent overuse and resource damage.	Demands through year 2020 can be met by developing 30 additional acres (12 ha) of potential sites.	Same as NED	Same as NED	Administration of National Forest Land PL 87-703 RC&D PL 83-566	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers National Park Service Colorado Division of Parks and Outdoor Recreation Colorado State Board of Land Commissioners Colorado Department of Local Affairs Colorado Division of Wildlife Soil Conservation Districts Four Corners Regional Commission
Changes in land management policies and legal procedures are needed to reduce costs and expedite obtaining rights-of-way; area access should be dictated by use need rather than by conjunctive use financing.	Would provide greater access in conjunction with increased timber management activities.	Because of less timber management activity, less access will be provided.	Advocates minimum access system consistency with use; little access provided through timber management.	PL 87-703 RC&D	Bureau of Land Management U. S. Fish and Wildlife Service Corps of Engineers National Park Service Colorado Division of Parks and Outdoor Recreation Colorado State Board of Land Commissioners Colorado Division of Water Resources Colorado Department of Local Affairs Colorado Division of Wildlife Soil Conservation Districts Four Corners Regional Commission Bureau of Reclamation

TABLE 1-1
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RIO GRANDE BASIN, COLORADO

CHAPTER III LOCAL PROBLEMS AND NATIONAL OBJECTIVES				CHAPTER IV RESOURCE BASE	CHAPTER V ECONOMIC PROJECTIONS AND ENVIRONMENTAL PREFERENCES	CHAPTER VI FUTURE WITHOUT PRODUCTION AND ENVIRONMENTAL CONDITIONS
National Objective	Problems (Public Concerns)	Components of the Objectives: Desired Goods and Services	Components of the Objectives: Preferred Resource Treatment	Resources		
NED 17	Insufficient timber supply to operate existing mills at capacity; Current level of timber management will not allow basin's resources to contribute their share of nation's future needs; Significant mortality in overmature and significant stagnation in immature stands.	Increased or more efficient output of forest products.	Increase timber supply.	Commercial Timber Resources (Acres / Hectares) Forest Service: 197,614 / 79,974 Roadless Areas: 603,128 / 244,086 Multiple-Use: 5,455 / 2,208 Potential Rec. Sites: 20,209 / 9,098 Bureau of Land Management: 164,330 / 66,371 Private: 47,732 / [illegible] State & Private Mixed Totals: w/Roadless Areas: 1,337,938 / 420,354 w/o Roadless Areas: 340,324 / 340,[illegible]	OBERS E' Basin Allocation - Timber Year / Million Board Feet 1980 / 60 1990 / 76 2000 / 82 2010 / 83 2020 / 84	Future without-Timber Production Year / Million Board Feet (Log Scale) 1980 / 31 1990 / 42 2000 / 50 2010 / 55 2020 / 70
NED 18	Fluctuating under and over utilization of recreation resources.	More efficient output of recreation opportunities.	More efficient utilization of recreation resource.	Society itself must adjust its attitudes, customs and mores to dampen extremes in periodic utilization of recreation resources.	See NED 15	See NED 15
EQ 1	Wind erosion.	Preservation of the land resource base.	Decrease wind erosion in San Luis Valley.	See NED 7	See NED 7	See NED 7
EQ 2	Lack of recreation areas and facilities.	Preserve the quality aspects of water, land, and air.	Install recreation areas and facilities using safeguards to maintain water, land, and air in an acceptable condition.	See NED 15	See NED 15	See NED 15
EQ 3	Water pollution is being caused by mine drainage and agriculture runoff.	Enhancement of quality aspects of water.	Decrease mine and agricultural runoff.	Mine Pollution Number of streams affected ---- 12 Miles of streams affected ---- 69 111 km Agricultural Pollution Area of land subject to runoff - 243,000 acres 98,342 ha	See NED [illegible]	See NED [illegible] - 9
EQ 4	Opportunities for scientific investigation and recreation in a wilderness setting may be significantly diminished.	Preserve wilderness opportunities.	Classify all undeveloped roadless areas (UDRA) as wilderness.	Wilderness Resources (Acres) Existing Wilderness Areas: 149,054 60,347 ha Inventoried Roadless Areas: 463,920 187,748 ha	Basin Allocation - Wilderness Recreation Year / Visitor Days Wilderness 2020 / 796,800 Backcountry 2020 / 531,200 Total 2020 / 1,328,000	Future Without-Available Wilderness Recreation Year / Visitor Days Wilderness 2020 / 42,000 Backcountry 2020 / 0 Total 2020 / 42,000

TABLE 1-1
REPORT CONTENTS OUTLINE
RIO GRANDE BASIN, COLORADO

CHAPTER VII NEEDS - PROJECTED DEMANDS AND PREFERENCES NOT SATISFIED BY FUTURE WITHOUT PRODUCTION	CHAPTER VIII ALTERNATE PLANS Effectiveness of Alternative Plans National Economic Development	 Alternate	 Environmental Quality	CHAPTER IX OPPORTUNITIES FOR USDA PROGRAMS IN THE ALTERNATE PLAN USDA PROGRAMS	CHAPTER X COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT NON-USDA PROGRAMS
Needs - Timber Production Year / Million Board Feet (Log Scale) 1980 29 1990 34 2000 32 2010 28 2020 14 More aggressive reforestation and thinning operations must be initiated; private timber management needs to be promoted; and public forest management practices need to be intensified.	Demands are beyond capability: Year / Capability as % of Demand 1980 85 1990 71 2000 74 2010 73 2020 80 For 5 decades 77 Timber supply is more than adequate to operate mills at capabicy on a one-shift basis; losses to mortality would decrease as harvesting increases; stand release operations to maintain productivity would eliminate stagnation.	Demands are beyond capability: Year / Capability as % of Demand 1980 70 1990 64 2000 63 2010 65 2020 67 For 5 decades 66 Supply midway between current subsistency level and maximum; little loss to mortality and little stagnation because of relatively high production schedule.	Demands are beyond capability: Year / Capability as % of Demand 1980 50 1990 43 2000 43 2010 42 2020 42 For 5 decades [illegible] Supply only sufficient to operate mills at current levels; increases in losses due to mortality and further stagnation is to be expected.	Administration of National Forest Land Cooperative Programs on State & Private Lands Clarke-McNary Act of 1924 Soil Conservation & Domestic Act of 1936 Pest Control Act of 1947 Cooperative Forest Management Act of 1950 Agriculture Act of 1956 Rural Development Act of 1972	Colorado State Forest Service
See NED 15	Plan itself has no effect; degree of fluctuation will subside as society moves more toward flexible daily work schedules, staggered vacation periods, longer weekends, etc.	Same as NED	Same as NED	None.	None
See NED 7	See NED 7			PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D (Urban Development)	Colorado State Forest Service Bureau of Land Management National Park Service Colorado Water Conservation Board Colorado State Board of Land Commissioners Soil Conservation Districts Colorado Division of Wildlife Extension Service
See NED 15	See NED 15			See NED 15	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers National Park Service Colorado Division of Outdoor Recreation Colorado State Board of Land Commissioners Colorado Division of Water Resources Colorado Department of Local Affairs Colorado Division of Wildlife Soil Conservation Districts Four Corner Regional Commission
See NED [illegible]	Includes 50 projects; therefore would be as or more effective.	Same as NED	Provides for curtailing pollution from these sources in Kerber Creek and Pito Seco Watershed.	PL 83-566 - Watershed PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D Administration of National Forest Land	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers Colorado Water Conservation Baord Colorado Division of Water Quality Control Colorado State Board of Land Commissioners Colorado Department of Local Affairs Soil Conservation Districts Four Corners Regional Commission Environmental Protection Agency
Needs - Wilderness Recreation Year / Visitor Days/Year Wilderness 2020 754,300 Backcountry 2020 531,700 Total 2020 1,286,000	Demand beyond capability; 263,104 wilderness/backcountry acres [106,478 ha] provide 2% of demand.	Demand beyond capability: 260,224 wilderness/backcountry acres [186,253 ha] provide 5% of demand.	Demand beyond capability: 613,529 wilderness/backcountry acres [248,295] provide 5% of demand. Area represents total suitable under 1973 standards.	Administration of National Forest Land	Bureau of Land Management U. S. Fish and Wildlife Service National Park Service

TABLE 1-1
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CHAPTER III LOCAL PROBLEMS AND NATIONAL OBJECTIVES				CHAPTER IV RESOURCE BASE	CHAPTER V ECONOMIC PROJECTIONS AND ENVIRONMENTAL PREFERENCES	CHAPTER VI FUTURE WITHOUT PRODUCTION AND ENVIRONMENTAL CONDITIONS
National Objective	Problems (Public Concerns)	Components of the Objectives: Desired Goods and Services	Components of the Objectives: Preferred Resource Treatment			
EQ 5	Decreasing big game winter range.	Preservation of wildlife.	Maintain or increase carrying capacity of big game winter range.	Effective Deer-Elk Winter Range Resources: Owner/Administrator — Acres — Hectares Forest Service — 200,000 — 80,940 Bureau of Land Management — 317,560 — 128,517 Private — 76,800 — 31,081 State & Private Mixed — 176,670 — 71,498 Total — 771,030 — 312,036	Maintain present winter range area 771,030 acres, (312,036 ha), and big game migration routes, but increase big game forage production on winter range to attain maximum big game animal unit months (115,480) by foregoing all livestock grazing on winter range.	Development trends in the Basin, if continued, would decrease the effective winter range area by at least 35,000 acres (14,100 ha), but more intensive management of the remaining area would allow the big game herds to be maintained with the 48,400 big game animal unit months of forage still available. Concurrent with the decline of the winter range area, however, will be the reduction of migration routes by linear subdivision and increased road construction. One can not assume that, since fewer or equal numbers of big game animals would exist, there is less concern for maintaining migration routes - the combined effects of loss of winter range in one area and migratory routes to the remaining winter range in another area could multiply the impacts.
EQ 6	Big game migration routes are threatened by urban development.	Preservation of wildlife.	Maintain freedom of movement of big game along migration routes.			
EQ 7	Inadequate access to public land for hunting and fishing purposes.	Maintain or increase fishing and hunting opportunities.	Obtain rights of way.	See NED 16	See NED 16	See NED 16
EQ 8	Degradation of trout habitat due to siltation of streams by road construction and timber harvest activities.	Preservation of wildlife.	Modify road building and timber harvesting activities to reduce stream siltation.	Coldwater Fishery Resources Streams — 1211 miles — 1948 km Lake and Reservoirs — 1800 acres — 729 ha	Initiate and accelerate management practices that minimize erosion from road construction and timber harvesting. reduce amount of raod; restrict off-road vehicles	If assumptions are near correct, no further degradation will take place on private lands. Public land management practices themselves may not further aggravate siltation. However, resource damage from increased off road vehicle use may not allow the situation to improve on public lands.
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	Preservation of biological resource.	Maintain quantity and quality of habitat of peregrine falcon, greater sandhill crane, whooping crane, mexican duck, black-footed ferret, wolverine, river otter, lynx, gray wolf, grizzly bear and Rio Grande cutthroat.	Little is known of numbers or habitat requirements. Fish and wildlife on federal and state endangered and threatened lists: 1) Rio Grande cutthroat trout 2) peregrine falcon 3) black-footed ferret 4) greater sandhill cranes 5) whooping cranes 6) mexican duck 7) river otter 8) wolverine 9) lynx 10) grizzly bear 11) gray wolf	Avoid extinction of the species by maintaining their habitat; taking such measures as necessary to increase their numbers and improve their habitat; reintroducing those species known to have inhabited the area; and pursuing land management programs compatible with the propagation of the affected species	With an approved recovery plan for the peregrine falcon, positive efforts will continue for this species. but funding for program implementation is not likely to be adequate. Since one of the habitat requirements of the black-footed ferret is prairie dog towns, it can be expected that on private lands this segment of its habitat will decline because of prairie dog eradication programs. On public lands no special action is planned to preserve or destroy the prairie dog, so it can be surmised that its habitat will generally remain unchanged from the present. Adequate habitat for the larger mammals on the Endangered and Threatened list (wolverine, gray wolf, grizzly bear and lynx) would probably be provided by the 380,000 acres (153,786 ha) of wilderness areas assumed under future without plan conditions. These acres would allow propagation of the species, if present, or restocking if no species remain. Drainage of any wetlands will remove habitat acres for the greater sandhill crane, whooping crane, Mexican duck and river otter. While water impoundments constructed under this condition will have some beneficial effects for some species, the shallow water environment lost through land reclamation projects can not be offset. Only the 23,000 (9,308 ha) acres of the U. S. Fish and Wildlife Service's Refuges at Alamosa and Monte Vista can be certain of wetland preservation.
EQ 10	Smoke from sawmill burners degrades air quality.	Preserve quality of air.	Decrease air pollution from sawmill burners.	Entire commercial forest resource may contribute to future log supply for forest products industry.	Dispose of sawmill wastes by modification and further processing into useable products to avoid burning.	The State Air Pollution Control Commission will issue new emission standards in 1979 which will allow opacity reduction greater than 20% only during start-up and shut-down periods. Sawmills will either quit burning or install adequate burners.

TABLE 1-1
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CHAPTER VII NEEDS - PROJECTED DEMANDS AND PREFERENCES NOT SATISFIED BY FUTURE WITHOUT PRODUCTION	CHAPTER VIII ALTERNATE PLANS — Effectiveness of Alternative Plans: National Economic Development	Alternate	Environmental Quality	CHAPTER IX OPPORTUNITIES FOR USDA PROGRAMS IN THE ALTERNATE PLAN — USDA PROGRAMS	CHAPTER X COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT — NON-USDA PROGRAMS
Big game winter range needs require maintaining the present area and developing the capacity to produce an additional 67,000 big game animal unit months over the future without conditions. Concurrent action is required to control development in the basin so as to permit the present and increased numbers of animals access to the winter forage.	Provides for only 38% of the preferred big game forage production because livestock grazing has priority; does not assure maintenance of any migration routes.	Sacrifices 1% in overall livestock forage production to increase big game forage production to 46% of preferred; migration routes to selected winter range areas would be assured to maintain herds at projected level.	Subdivisions eliminate 5% of winter range, but still allowing 94% of preferred production; no hindrance to migration will occur; no livestock grazing is allowed on any winter range, resulting in 6% of production loss.	Administration of National Forest Land None.	Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Colorado Division of Wildlife Colorado Division of Parks and Outdoor Recreation Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Colorado Division of Wildlife Colorado Division of Parks and Outdoor Recreation Colorado Land Use Commission
See NED 16	See NED 16			Administration of National Forest Land	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Colorado Division of Parks and Outdoor Recreation Colorado Division of Water Quality Control Colorado Division of Wildlife Soil Conservation District Four Corners Regional Commission
Greater environmental concern must be exercised in designing and actual road construction on all forest lands; off-road-vehicles need to be controlled to avoid resource degradation.	Creates little more erosion and sediment (3%) than EQ 5-decade period because of heavy reforestation and rapid upgrading of forest roads.	Produces most erosion and sediment - 14% more than EQ in 5 - decade period; reforestation and roads improvement are not accomplished as quickly as NED.	Embraces most favorable conditions because of least road construction and timber harvesting.	Administration of National Forest Land	Colorado State Forest Service Bureau of Land Management Corps of Engineers Colorado Water Conservation Board Colorado State Board of Land Commissioners Colorado Division of Wildlife Soil Conservation District
If the endangered and threatened species are to be preserved or reintroduced in the Rio Grande Basin, much more emphasis needs to be directed toward actual implementation of positive measures to determine: existing populations of the various species; their habitat requirements, land management implications on the habitat; and reintroduction feasibility of non-resident species.	Allows for no special measures to propagate resident species or reintroduce non-resident species. Drainage of lowlands is to detriment of cranes and ducks. Limited undeveloped areas (263,200 acres) (106,436 ha) allows little habitat for wolverine, wolf, lynx and bear; funds for falcon will be less than optimal; habitat for ferret declines, but otter will be little affected; trout will benefit	Results in same conditions as NED except: more remote areas (460,000 acres) (186,162 ha) are available for wolverine, wolf bear and lynx habitat; adequate funding for falcon is available; ferret habitat is maintained; and trout habitat is adversely affected.	Provides best option; very little lowland habitat impacted; over 600,000 acres (242,820 ha) of remote country available for larger predatory animals, prairie dog towns are preserved or expanded, necessary funds for falcon are available, generates best trout habitat.	Administration of Nation Forest Land	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers Colorado Division of Parks and Outdoor Recreation Colorado Board of Land Commissioners Colorado Division of Water Resources Colorado Division of Wildlife Four Corners Regional Commission
The need is to process more than 26,000 tons (23,582 t) per year of sawmill waste into saleable products or pollution free elimination.	Provides for waste disposal in most economically feasible manner consistent with meeting air quality standards.	Advocates beneficial disposal of wastes by further use in energy, crop and livestock production; attempts disposal well within air quality standards.	Requires that wastes be put to environmentally beneficial use either as soil modifier, cattle feed or energy production with no adverse effect on air quality; burn only would no be an option.	Cooperative Forest Management Act of 1950 PL 87-703 RC&D	Colorado State Forest Service Colorado State Board of Land Commission Colorado Department of Local Affairs Colorado State Air Pollution Control Commission Four Corners Regional Commission

TABLE 1-1
REPORT CONTENTS OUTLINE
RIO GRANDE BASIN, COLORADO

INTRODUCTION

CHAPTER II- INTRODUCTION

A. Authority and Study Initiation

This report presents information concerning water and related land resources of the Rio Grande Basin in Colorado resulting from a cooperative study by the Colorado Water Conservation Board and the United States Department of Agriculture. The Board's request for this study stems from its legislative authority which charges the Board with these responsibilities: (1) to promote the conservation of the waters of the state of Colorado in order to secure the greatest utilization of such waters and the utmost prevention of floods, and (2) to cooperate with the United States and the agencies thereof, and with other states, for the purpose of bringing about the greatest utilization of the waters of the state of Colorado and the prevention of flood damages.

Department of Agriculture participation in the study is authorized under the provisions of Section 6, Public Law 83-566, 1954 (Watershed Protection and Flood Prevention Act), as amended, which directs Department cooperation with other federal, state, and local agencies in making investigations and surveys of the watersheds of rivers as a basis for the development of coordinated water and related land resource programs. The study was authorized by the Administrator of the Soil Conservation Service on July 21, 1970.

B. Department of Agriculture Responsibilities

Investigations and survey activities of the U. S. Department of Agriculture (USDA) were performed under the direction of the USDA Field Advisory Committee, Colorado Rivers, composed of representatives of the Economic Statistics Cooperatives Service, U. S. Forest Service, and the Soil Conservation Service. The participation of these agencies was in accordance with the Memorandum of Understanding between them dated February 2, 1956, and revised April 15, 1968.

C. Colorado Water Conservation Board's Role

Throughout the study, the Colorado Water Conservation Board worked closely with members of the Field Advisory Committee and technicians of the Soil Conservation Service, the Forest Service, and the Economic Statistics Cooperatives Service. Its staff participated in the preparation of the Plan of Study, the Detailed Work Outline, and the development of problems and needs in the basin. Assistance was furnished in the development of basic data concerning the availability and utilization of existing surface and ground water supplies and the administration of water use as provided for in the Rio Grande Compact.

D. Ad Hoc Committee

Initially a series of public meetings were held in the basin to obtain public input into the planning process. Groups at these meetings represented resource users and controller groups, conservation groups, civic and miscellaneous groups and individuals.

To obtain action and assistance from such a large group is difficult in the planning process. Consequently, an Ad Hoc Committee was formed with representatives from various local groups and organizations. The function of the Ad Hoc Committee was to consider the proposals and suggestions of the planners in light of the local basin situation, as well as identifying and reviewing:

- alternative means for solving basin problems;

- effects of alternative plans.

With the Ad Hoc Committee providing representation for local interests, a link was established for effective local input to the planning process.

E. Study Objectives and Procedures

Information generated from this study should provide a basis for more effective coordination of federal, state and local programs for watershed protection, flood prevention, agricultural water management, recreation, fish and wildlife development, municipal and industrial water development, and range and forest administration. The assemble and analysis of data pertaining to 20 subject areas (particularly resources, land resource inventories, agricultural pollutants, and social and economic indicators) was involved. The analysis was conducted in a framework of identifying impacts within National Economic Development and Environmental Quality Objectives as prescribed by the USDA Procedures for Planning Water and Related Land Resources.

Other objectives included: analyzing the basin's economy relative to present conditions, historic trends, and projections; determining the cause, extent and frequency of the basin's resource problems; determining the present and future need for development based on resource problems and projected economic activity; describing the physical capability of the basin to supply water and related land resources for development to meet identifiable needs; and identifying opportunities and impacts of USDA projects and programs in alleviating problematic situations.

F. General Description

The Rio Grande is one of the longest rivers in the United States, surpassed only by the Missouri and Mississippi Rivers. Its headwaters rise in the southern Rocky Mountains of Colorado, flowing some 1,800

Rio Grande at Wagon Wheel Gap, Colorado

miles (2,896 km) to the Gulf of Mexico and draining 185,000 square miles (479,150 km^2) of Colorado, New Mexico, Texas and Mexico. For more than half its length the Rio Grande is the international boundary between the United States and Mexico, giving this river international as well as interstate importance.

This study area includes the portion of the Rio Grande found in Colorado which contains the entire headwaters of the river. The Rio Grande Basin in Colorado encompasses about 5 million acres (2,023,500 ha) in south-central Colorado and is bounded on the west and north by the Continental Divide (San Juan Mountains), on the east by the Sangre de Cristo Range, and on the south by the Colorado-New Mexico State Line. The physiography varies from a high mountain desert of 7,500 feet (2,286 m) with an

annual precipitation of 7 inches to towering mountains in excess of 14,000 feet (4,267 m) with annual precipitation of up to 45 inches (1.14 m).

G. Acknowledgment of Data

In addition to the United States Department of Agriculture and the Colorado Water Conservation Board, several other federal, state, and local agencies have provided data and assistance for this report. Contributors were the U. S. Geological Survey, U. S. Bureau of Land Management, U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service, U. S. National Park Service, Science and Education Administration-Federal Research, U. S. Bureau of Census, National Weather Service, Colorado Department of Natural Resources, Colorado Division of Water Resources, Colorado Division of Commerce and Development, Colorado State Soil Conservation Board, Colorado State Forest Service, Colorado Division of Public Works, Colorado Department of Agriculture, Colorado Division of Parks and Outdoor Recreation, Colorado Division of Wildlife, Rio Grande Compact Commission, Rio Grande Water Conservation District, Four Corners Regional Commission, San Luis Valley Regional Planning Commission, San Luis Valley Council of Governments, San Luis Valley Resource Conservation and Development, the Mosca-Hooper, Center, Conejos County, Rio Grande, and Costilla Soil Conservation Districts, and the water user's associations and conservancy districts within the basin.

CHAPTER III

LOCAL PROBLEMS AND NATIONAL OBJECTIVES

CHAPTER III - LOCAL PROBLEMS AND NATIONAL OBJECTIVES

Water and land resource problems occurring in the Rio Grande Basin prompted the Colorado Water Conservation Board to request the Department of Agriculture to conduct this study. Meetings held in the basin permitted state and local public the opportunity to express their land and water problems. These locally perceived problems are more far-reaching in nature than is first apparent in that they inhibit achieving nationally defined objectives. By assimilating the local problems into National Economic Development and Environmental Quality objectives, the problems can be broken down into specific study components. This procedural direction is contained in the Water Resource Council's Principles and Standards as published in the Federal Register dated September 10, 1973. The purpose of the first section of this chapter is to discuss the problems in light of the local circumstances, while the second section relates these problems to national objectives and study components.

A. Problems

1. Water

Problems related to water are quite common to most western states--insufficient water supply, shortage of water supply storage facilities, flooding, overappropriation of streamflow, and water pollution.

a. Water Supply

If the entire average annual water supply (1,577,000 acre feet [1,945 million m^3]) were available for cropland use (609,590 acres [246,700 ha]), it would amount to 2.59 acre feet (3,195 m^3) of water per acre of cropland. At an efficiency of use of 46 percent and an ideal timing of runoff, the water supply would be adequate to meet the cropland needs. This, however, is not the case. Approximately 23 percent of the average annual water supply flows to downstream states, another 36 percent is transpired by low economic value phreatophytes, and an additional 1 percent goes to evaporation from water areas and municipal uses. Therefore, about 40 percent of the water supply is consumptively used by crops in the basin, which is not sufficient to meet the needs.

The actual shortages would be much more severe if it were not for the re-use of return flows, and the influence of the ground water system and existing surface reservoirs. The ground water and surface reservoirs greatly facilitate the distribution of water to more fully meet the timing of the crop needs. However, there still remains a crop consumptive use deficiency of about 13 percent during an average year. The shortage occurs in late summer when there is a high water demand and a low water supply.

Terrace Reservoir - No late season irrigation water

Surface Water Available for Irrigation
(Acre Feet per Acre)
(cubic metre per hectare)

	April	May	June	July	Aug.	Sept.	Season
At point of Diversion	0.171 (521.7)	0.600 (1830.1)	0.634 (1931.9)	0.323 (985.4)	0.207 (631.5)	0.133 (404.9)	2.068 (6305.5)
1/ Available for Consumptive Use	0.050 (151.3)	0.174 (530.7)	0.184 (560.3)	0.094 (285.8)	0.060 (183.1)	0.036 (117.4)	0.598 (1828.6)

1/ Based on 29% efficiency and 609,600 (246,700 ha) irrigated acres. An additional 0.457 acre feet per acre (1393 m^3 per ha) is pumped from ground water.

Municipal water supply problems are experienced by 16 out of 25 communities investigated. These problems are related more to facilities needed to handle the water supply than to the actual supply itself. Inadequate storage, pumping treatment and distribution systems comprise the more common problems.

b. Flooding

Table III-1 lists communities and agricultural land having special flood hazards. Detailed studies have been made for three of the communities listed: The U. S. Army Corps of Engineers prepared a Flood Plain Information Report in 1969 for a reach of the Rio Grande between Seven Mile Plaza and the Home Lake Road east of Monte Vista; a flood insurance study for Alamosa, and preliminary studies have been made by the Corps, as well as the Soil Conservation Service, on Rito Seco Creek near the town of San Luis.

Flooding on agricultural lands

TABLE III - 1

FLOOD HAZARDS

Rio Grande Basin, Colorado

Source of Flooding Watershed	Type of Flooding: Urban	Affected Communities	Agricultural
Rio Grande	x	Alamosa Del Norte Monte Vista Navajo Trails Seven Mile Plaza	x
Alamosa Creek	x	Capulin	x
Conejos River	x	Guadalupe	x
La Jara Creek	x	La Jara	x
Rito Seco Creek	x	San Luis	x
Willow Creek	x	Creede	x
Kerber Creek	x	Bonanza Villa Grove	x
N. Crestone Creek	x	Crestone	
Saguache Creek	x	Saguache	x
Culebra Creek	x	San Luis	x
Rock Creek			x
San Antonio River			x
La Garita Creek			x

Flooding of agricultural lands occurs on a fairly regular basis. Flooding along much of the Rio Grande is not uncommon during spring runoff even though much of the excess water is diverted into major canals to reduce the downstream flows. Major points of irrigation diversion on the river are in the vicinity of Del Norte, with some channel deterioration occurring over the years as a result of these diversions. When flows do exceed channel capacity, flooding occurs over relatively large acreages of pasture, "Chico Lands" and wildlife areas. Similar conditions exist along the Conejos and San Antonio Rivers, and La jara, Alamosa, and Rock Creeks.

Erosion and sediment deposition problems associated with flooding create damage environmentally as well as economically. Watersheds having erosion problems are often those that have been overused or misused through some past period of time. Most of the basin is considered in the low sediment yield range. Three general areas yielding moderate rates of sediment are shown in Figure III-1 as the middle and lower elevations of the Sangre de Cristo mountains in Central Costilla County, the foothills between Saguache Creek and Carnero Creek, and south of Villa Grove.

Watershed Investigation Studies were made on Chama Canyon, Culebra Creek, Rito Seco Creek, Saguache Creek, Kerber Creek, and La Garita Creek. The La Garita Creek watershed is typical of others in the basin and was selected to illustrate associated problems:

> The La Garita watershed (82 square miles [212 km^2] drainage area) supplies water for 6,100 acres (2,469 ha) of irrigated cropland, with the Rio Grande Canal, which crosses the watershed, serving another 24,000 acres (9,713 ha) downstream. Agriculture is the primary source of income for the residents.
>
> Floodwaters and sediment affect 900 acres (364 ha), of which 700 (283 ha) are irrigated. A potential flooding hazard exists on 1,400 acres (567 ha) if the Rio Grande Canal should be breached by high flows. Other problems as a rule include icing on cropland in winter and insufficient irrigation water for the late season.

c. Overappropriation of Streamflow

The Colorado Doctrine adopted in 1876 and judicial decisions state that (1) water in its natural course is the property of the public and is not subject to private ownership; (2) a

[illegible] agricultural lands occurs on a fairly regular [illegible] along much [illegible] the Rio Grande is not uncommon [illegible] of the [illegible] water is [illegible] major canals to reduce the down stream flow [illegible] points of irrigation diversion on the river [illegible] vicinity of Del Norte [illegible] channel [illegible] over the years as a result [illegible]

[illegible]

[illegible]

[illegible]

Overappropriation of Streams.

The Colorado [illegible] adopted in 18[illegible] judicial decision [illegible] that [illegible] water in its natural course is the property of the public and is not subject to private ownership [illegible]

SEDIMENT YIELD
RIO GRANDE BASIN
COLORADO

FIGURE III - 1

vested right to use the water may be acquired by appropriation and application to beneficial use; (3) the person first in time to use the water is first in right; and (4) beneficial use is the basis, the measure and the limit of the right.

Through the years, rights to the use of water have been granted with priorities established according to filing dates. The more recent applicants are entitled to water only after priorities senior to them have been met. Normal snowpack and attendant runoff usually provide sufficient water to most irrigators during the early part of the irrigation season. Direct flow diversions to junior appropriators are, in most years, curtailed or prohibited because of low streamflow during the late irrigation season, the lack of adequate storage facilities, and Colorado's obligation under the Rio Grande Compact. Ground water is pumped to supplement inadequate surface supplies which alleviate the effects of streamflow over appropriation. Pumping is curtailed, particularly in years of water shortage, because of junior water rights.

d. Water Pollution

(1) Sediment

Sediment, an end product of soil erosion, is by volume the greatest single pollutant of surface waters and the principal carrier of some chemical pollutants. In some watersheds sediment from non-agricultural sources exceeds that from cropland, and in regions of low rainfall or sandy soils, wind erosion may exceed water erosion. Most of a watershed's sediment comes from a few relatively small areas that need special attention. Sediment problems are relatively insignificant in the Rio Grande Basin. (See Figure III-1.)

Conditions conducive of soil erosion in cropland include:

- No crop residues on surface after new crop seeding.
- No cover between harvest and establishment of new crop canopy.
- Intensively farmed land adjacent to stream without intervening strip of vegetation.
- Runoff from upslope pasture or rangeland flowing across cropland.
- Poor stands or poor quality of vegetation.

Other high potential sources of sediment are:

- Gullies
- Residential or commercial construction.
- Highway construction.
- Poorly managed range, idle, or wooded areas.
- Unstabilized streambanks.
- Surface mining areas.
- Mine tailing from subsurface mines.
- Unstabilized roadbanks.
- Bare areas of non-cropland.

(2) Fertilizers

The potential for pollution from fertilizers is generally highest where large acreages are treated with high rates of fertilizers. Large acreages treated with low rates of fertilizers or small acreages treated with high rates will usually not have a significant effect although they might be of concern under local conditions.

(3) Pesticides

Concentrations are very low and the total pesticide runoff during the crop year is often much less than 5 percent of the application except when runoff occurs immediately after application. Nevertheless, some chemicals are an environmental concern as they are highly toxic to fish or other aquatic fauna and can persist in the aquatic environment for a long time. On the other hand, many agricultural chemicals are not acutely toxic to animal life; they do not persist from one crop season to the next nor do they accumulate in food chain organisms. These chemicals may be used at normal application rates without fear of causing unacceptable environmental damage.

(4) Animal Wastes

The pollution potential from using manure with poor management can be substantially higher than that from

using commercial fertilizers, because nearly all manure is spread on the soil surface and can contain large amounts of soluble carbon, nitrogen, and phosphorus compounds. These constituents can be easily lost if runoff occurs before the manure is incorporated into the soil. Application of manure in excess of the amount required to supply crop mitrogen needs can result in nitrate leaching to ground water.

(5) Mine Tailings

Willow, Alamosa, and Kerber Creek Watersheds are contaminated by chemicals and sediments. They have mine tailings along them associated with previous and present mining operations. These yield chemicals and sediment that are deposited on pasture and cropland further downstream.

Water pollution - mill tailings

2. Irrigation

Irrigation methods employed include flooding, border, furrow, subirrigation and sprinkler. Recently, sprinkler irrigation systems have been installed as fast as equipment companies can supply them. This trend is causing a continuing increase in ground water withdrawals and some reduction in streamflow diversions that were used as surface irrigation. "Ground water mining" could occur or is already a reality in some localities if this situation should continue without compensating natural or artificial ground water recharge.

Surface irrigation problems center around water losses from canals and ditches, inefficient utilization of irrigation systems, and poor irrigation water management. It is not uncommon to see separate canals located side-by-side for several miles (km), and in some cases actually crossing each other, mainly because of ditch ownership and water right priority. Rates of seepage loss vary considerably through the irrigation season in areas subject to high water table conditions. During the spring, seepage losses are high as a result of permeable soils and a low ground water table. As the runoff season progresses and the ground water table rises, canal seepage decreases. In wet areas a canal may actually pick up water, acting as an open drain.

Headgate structure needing replacement

Some residents do not consider these seepage losses a problem. They consider the loss as a means of providing ground water recharge and habitat for wildlife. Ground water recharge is important to those who depend on sub-irrigation and sprinkling method for crops, while others who depend on diversions from streams as their only water supply are concerned about high seepage losses.

Water Supply and Irrigation Requirement
Ac. Ft. per Ac. (M^3 per ha)

	April	May	June	July	Aug.	Sept.	Season
Consumptive Water Supply	0.050 (151.3)	0.174 (530.7)	0.184 (560.3)	0.094 (285.8)	0.060 (183.1)	0.036 (117.4)	0.598 (1828.6)
Consumptive Irrigation Requirement	0.023 (70.1)	0.128 (390.1)	0.309 (941.8)	0.364 (1109.5)	0.243 (740.7)	0.127 (387.1)	1.194 (3639.3)

NOTE: Based on 29% efficiency and 609,600 acres (246,700 ha) irrigated. Pumped ground water not included.

3. Cropland

a. Drainage

The large network of irrigation canals built between 1880-1890 brought about a rise in ground water levels to such an extent that lands in the lower parts of the basin became waterlogged. With continued large diversions from the Rio Grande to the porous and shallow soils, the water table rose to the soil surface on the east and to a level within 10 to 15 feet (3.1 to 4.6 m) of the surface on the west. This caused abandonment of acreages along the east side of the basin with concomitant substitution of lands farther west. Drainage to reclaim waterlogged lands in various parts of the basin began about 1911, but large areas between the present irrigated area and the old eastern boundary are still not reclaimed.

Drainage ditch south of Alamosa, Colorado

b. Wind Erosion

Strong winds normally out of the southwest in the spring and early summer frequently cause dust storms. Lack of rainfall limits the density of natural vegetative cover. Irrigated cropland does not have a protective residue cover remaining due to excessive fall plowing. Soil may also become susceptible to wind erosion from improper tillage, weathering and lack of organic matter. The wind blown soil often fills irrigation and drainage ditches.

c. Low Inherent Fertility and Organic Matter

Low inherent fertility and organic matter are common in soils of the basin. Many of the agricultural soils are mixed fine

to coarse textured sandy alluvium, are shallow and rocky with little organic matter and are low in water holding capacities. Although these soils are low in fertility, they can be quite productive if properly fertilized and irrigated. Improved management and vegetative practices of farming operations could increase production by utilizing residue-producing and nitrogen-fixing crops, green manures, grass or alfalfa.

d. Noxious Plants

Several noxious plants grow in the basin that could be replaced by valuable forage plants to realize maximum forage production. These include sagebrush, greasewood, rabbitbrush and two half-shrubs--pingue and snakeweed, which are not valuable forage plants but are considered valuable wildlife plants. Areas around roadways, irrigation drainages, delivery and field ditches, farmsteads, and other areas that are not tilled regularly support many noxious plants. At the same time many of these areas may be valuable as wildlife habitat. In any case, many programs for control of noxious plants would have to be implemented through local units of government.

Hay meadow - west of Villa Grove, Colorado

e. Limited Crops

The Rio Grande Basin Colorado boasts of being the largest and highest intermountain valley in the United States. The frost-free season ranges from about 90 to 115 days and precipitation averages about seven inches a year. Because of the low rainfall, cropland has to be irrigated to produce crops. The main irrigated crops are alfalfa, potatoes, vegetables, feed and malt barley, oats, grass hay and pasture. Native hay or pasture on high watertable areas are an important part of many farms and ranches. Crop yields are high and quality of adapted crops usually good. Research through research agencies and the Colorado State University experimental station are being carried out to introduce new crop varieties.

4. Forest Related Lands

The total capacity of the sawmills in the basin is 60 million board feet per year on a single-shift basis, or about 120 million board feet maximum. The current timber management plan for the Rio Grande National Forest calls for 20 million board feet to be sold in FY 76 and 77. Additional manpower and funds for reforestation, timber stand improvements and road construction could allow the forest (utilizing all forested roadless areas) to sell as much as 60 million board feet per year; however, funding to this level is not anticipated. Relatively small amounts of timber are available from Bureau of Land Management (BLM), state and private lands. Thus, the currently available timber supply is significantly less than even the single-shift capacity.

Mortality and rot cause a significant decrease in the volume of useable wood available for harvest and manufacture into lumber and other building products. For example, an acre of overmature Engelmann spruce sawtimber of average site quality is estimated to lose 2,610 net board feet from age 200 to 250, or 52 board feet per year. The rate of loss increases as the age of the stand increases. Total losses on the Rio Grande National Forest in 1968 were estimated to be 25 million board feet.

In young stands of timber, too many trees can reduce the growth of useable wood. For example, an acre of Engelmann spruce seedlings and saplings with 1,144 trees with an average diameter of 2.1 inches (0.05 m) at age 20 is estimated to grow at the rate of 180 board feet per year (gross measure over a 140 year rotation). The same stand, if thinned at age 40 and age 100, could grow at a rate of 225 board feet per year, or 25% faster.

5. Range

The livestock industry is a major component of the basin's economy, centered primarily around cattle and sheep.

Though much of the lower lying land is grazed yearlong, the basin has a general pattern of seasonal use. Summer grazing occurs for about four months on the mountain open forestland and grassland of higher elevations. This period usually begins about the middle of June and ends approximately October 31. For the remainder of the year, grazing is found on lands of lower elevations.

The most critical shortage of forage comes in late winter/early spring as winter hay supplies, crop residues and pastures dwindle, and new plant growth has not yet had sufficient time to develop on summer ranges. The result is often the overgrazing of winter ranges and grazing of some summer ranges too early. Continued misuse of the range resource leads to its further degradation by invasion of less desirable forage plants and soil erosion. This resource abuse can be prevented through proper range management practices, and the resource can be improved to support more livestock.

6. Recreation and Wildlife

This study limits its recreational scope to those activities of outdoor recreation related to picnicking, camping, skiing, hiking, backpacking, fishing and hunting. It does not allude to team and spectator sports. Wildlife, as used here, is meant in its broadest form including game and non-game species of fish, waterfowl, birds and animals. Ascription to particular categories are so noted.

a. Areas and Facilities

Problems associated with recreation areas and facilities are often interdependent with access and fluctuating utilization. For example, on a summer weekend from all appearances a lack of camping and picnicking areas and facilities may be the rule while during the week the reverse may be the case. This is a common occurrence for these types of facilities, but nonetheless, the determination of demand in relation to supply is pursued in the study to ascertain the actual situation.

b. Access

Access to public land for hunting, fishing and recreation has been provided historically in conjunction with other land management activities, particularly timber management. There is no substantial foreseeable change in this situation, with isolated areas of public land having insufficient timber or other resource values capable of covering the cost of obtaining access. One method of providing access to these lands would be to acquire public rights-of-way on existing roads on private land involving numerous legal and institutional and cost aspects.

c. Fluctuating Utilization

Fluctuation in recreation resource utilization is a daily as well as a seasonal problem. Use is highly dependent upon socio-economic factors of the user population and also location of the resource itself. Fluctuation in the utilization of the resource is intertwined with societal customs, mores and religious beliefs. Most people have weekends free, while during the week when the recreation resource is unused few have time to participate in recreation.

d. Wilderness Opportunities

Wilderness settings in the basin for scientific and recreation purposes are presently provided by the Weminuche and La Garita Wilderness Areas created under the authority of the 1964 Wilderness Act. Further opportunities for solitude, a major criterium for establishing a wilderness area, could be gained by converting all, some, or parts of thirteen (The 1977 Roadless Area Inventory was completed before this report was published. However, it was too late to change the number and analysis so the 1973 inventory is used throughout this report) roadless areas to wilderness status. Wilderness status of forested lands foregoes any opportunity for future timber harvest on any area so designated without enabling congressional legislative action.

e. Big Game Winter Range and Migration

Migration of big game, primarily deer and elk, is the movement of herds between summer range (high country) and winter range (lower elevations). Certain facets of human occupation of an area may impede big game travel between these ranges by completely blocking the route and effectively prohibit the use of winter range areas, or cause alternate, less desirable routes to be established. Identified facets of this nature are linear subdivision development along rivers and highways, roads themselves, fences and other forms of human influence. Each of these items could be problematic to big game migration to one degree or another. At the same time that development impacts migration routes, much winter range acreage--vital to the survival of big game during critical months--may be permanently lost to the effects of rural subdivisions.

f. Fish Habitat

Some land use activities, such as mining, stream channel modifications, pipeline construction, silvicultural practices, deforestation and construction of water resource development

projects often cause immediate and long lasting effects on water if such activities are not conducted in a careful or proper manner. Since it is not possible to summarize adequately the complexity of all effects from all the interactions, just the fish and recreation water quality aspects of non-point source pollution from general land use activities in timber and range management are considered here.

A special case exists for the Rio Grande cutthroat trout which is considered by the Colorado Division of Wildlife to be a threatened species. Environmental alterations such as timber logging, road building, overgrazing or other activities may lead to increased turbidity or raise water temperatures which adversely affect Rio Grande cutthroat trout. Drying of stream beds and water diversions for agricultural irrigation are also major causes of habitat loss.

Public Law 92-500, the Federal Water Pollution Control Act, gives specific direction to restore and maintain the chemical, physical and biological integrity of the nation's water.

g. Endangered and Threatened Wildlife

The U. S. Congress and the State of Colorado have recognized that some species of wildlife have been so depleted in numbers that they are in danger of, or threatened with, extinction. The State Division of Wildlife has entered into a cooperative agreement with the Federal Fish and Wildlife Service, giving the state the authority and responsibility to administer programs to accomplish the purposes of the Endangered Species Act of 1973.

Endangered species or subspecies are those whose prospects of survival or reproduction within the state are in immediate jeopardy due to the destruction, drastic modification or severe curtailment of its habitat; its over-utilization for scientific, commercial or sporting purposes; the effect on it by disease, pollution or predation; or other natural or man-caused factors significantly affecting its survival or recruitment within the state.

Threatened species or subspecies are those not immediately faced with extinction, but are vulnerable because they exist in such small numbers or are extremely restricted throughout all or a significant portion of their range within the state.

Wildlife species recognized by the Colorado Division of Wildlife and/or the U. S. Fish and Wildlife Service as needing protection of habitat are the peregrine falcon, greater

sandhill crane, whooping crane, mexican duck, black-footed ferret, wolverine, gray wolf, grizzly bear, river otter, lynx and Rio Grande cutthroat trout.

7. Economic and Social

a. Rural Electrification

Energy requirements are becoming more and more difficult to satisfy because of demands through population expansion, development of natural resources, and installation of electrically driven well pumps for pivot sprinklers. Availability of economical electrical energy is a key element in the economy and, in turn, the power industry is directly affected by the economic climate.

b. Inadequate Sanitation

Sewage disposal hazards generally fall into two categories--public health hazards and general nuisances, including effects on natural beauty and recreation. Public health hazards may result in infection, epidemics and possibly death when sources of drinking water are contaminated through lateral seepage from sewage lagoons, septic tanks, or feedlot and barnyard runoff. Nuisances are created when recreational areas, lakes, rivers, etc. become polluted so that they are unsafe for water sports. The resultant odors and accompanying destruction of scenic areas which often occur can keep tourists away, thus resulting in economic losses. Also, property values can be affected and industry discouraged, which may be to the general economic detriment.

c. Poor Housing

The Rio Grande Basin has some of the oldest housing in Colorado. For example, in 1970 approximately 62 percent of the dwelling units were of 1939 vintage or earlier. A related characteristic of older housing is the lack of plumbing in many units, with over 19 percent of the units lacking some or all plumbing facilities and in Costilla County the figure being over 48 percent.

The 1970 figures also indicate that 76 percent of the "owner occupied" units were valued under $14,999, with many units within the basin being unoccupied. These data and that provided in Table III-2 would suggest that there is a need for considerable modernization and renovation of existing dwelling units.

Sawmill burner discharging smoke from
burning wastes

d. Air Quality

Currently most sawmills dispose of generated wastes (sawdust, bark, planer shavings, etc.) by burning in a structure called a "tepee burner". These were originally designed simply to contain the fire, not to promote efficient combustion in order to lessen air pollution.

TABLE III-2

SELECTED CHARACTERISTICS OF HOUSING INVENTORY - 1970

Rio Grande Basin, Colorado

County	Total Number of year-round units	Plumbing Facilities: Lacking some or all plumbing facilities	Plumbing Facilities: Lacking piped water	Year Built: 1965 to March 1970	Year Built: 1939 or earlier
SAN LUIS VALLEY	12,470	2,412	1,402	1,064	7,707
Alamosa	3,654	281	121	449	1,853
Conejos	2,406	678	457	140	1,741
Costilla	1,073	520	389	46	747
Mineral	489	92	28	47	264
Rio Grande	3,349	457	233	260	2,123
Saguache	1,499	384	174	112	979

Source: Colorado Division of Housing, 1972. Colorado Housing Current Inventory and Needs, January 1, 1972. Housing Vol. II. 1971 Projection Completion Rep. No. P-99, Denver, Colorado.

Under ideal conditions (warm weather, dry wood) complete combustion often occurs in the tepee burner unaided, resulting in a smokeless operation. However, under adverse conditions (cold weather, wet or frozen wood), considerable technology must be applied to achieve complete combustion. But even then, incomplete combustion and smoke takes place during start-up and shut-down periods. Thus, due to adverse conditions, at one time or another, all burning operations exceed the 20% opacity reduction standard currently in effect.

B. National Objectives

While the previous discussion brings locally perceived problems to light in relationship to the local situation, this section correlates the local problems to the national objectives of National Economic Development (NED) and Environmental Quality (EQ) as directed by the Water Resource Council's Principles and Standards. Some problems crosscut both objectives while others clearly fall under one or the other, but in any case, all the locally perceived problems are identified under either or both of the objectives.

The problems are then disected as to components of the objectives: On the one hand the "desired" goods and services necessary to alleviate the problem and attain the national objective are identified; on the other hand, one or more "preferable" resource treatments are identified to attain these desires and ultimately the national objectives. Simply, the former is the end and the latter a means to that end. The two national objectives, as applicable to the Rio Grande Basin, are defined below.

1. NATIONAL ECONOMIC DEVELOPMENT Objectives

Following study procedures as outlined in USDA Procedures for Planning Water and Related Land Resources," the NED objective in this basin was to increase the value of the Nation's output of goods and services and improve national economic efficiency, the two main sources for increased output being introducing additional resources created by such projects as drainage or irrigation; and more efficient use of resources. This includes technical external economies and employment of otherwise underemployed or unemployed resources. Efficiency can accrue either from achieving a higher level of output from the same resource or the same level of output with fewer resources. The efficiency of the Rio Grande Basin will be achieved primarily through output gains with fewer inputs. Components to the local problems of the NED objective are tabulated in Table III-3. A total of 18 problems were identified under this objective.

TABLE III-3

CORRELATION OF LOCAL PROBLEMS TO THE NATIONAL ECONOMIC DEVELOPMENT OBJECTIVE

Rio Grande Basin, Colorado

National Objective	Problems (Public Concerns)	Components of the Objective: Desired Goods and Services	Components of the Objective: Preferred Resource Treatment
NED 1	Inadequate water for late season irrigation.	Increased or more efficient output of food and fiber.	Provide water for late season irrigation. Increase the quantity and improve the timing of water yield from forested land.
NED 2	Over appropriation of streamflow. Withdrawals for Rio Grande Compact.	"	Manage water allocation to assure compliance with Water Compact and seasonal water need.
NED 3	Inefficient irrigation and delivery system.	"	Improve physical irrigation systems and water scheduling.
NED 4	Inadequate drainage.	"	Drainage of agriculture land.
NED 5	Flooding.	"	Improve the timing of water yield from forested land. Provide reduction in flood damage.
NED 6	Low inherent fertility and organic matter.	"	Improve management and vegetative practices of farming operations.
NED 7	Wind erosion.	"	Promote improved vegetative and management practices.
NED 8	Noxious weed control.	"	Increase application of herbicides.
NED 9	Limited range of crops.	"	Introduce new crop varieties.
NED 10	Inadequate rural electrification.	Increase supply of electric energy to San Luis Valley.	Increase high voltage electric lines serving valley.
NED 11	Underdeveloped range resources and overgrazing.	Increased and/or more efficient output of livestock products.	Increase forage production.
NED 12	Inadequate sanitation.	Reduce sanitary hazards.	Improve sewage and solid waste disposal.

TABLE III-3

CORRELATION OF LOCAL PROBLEMS TO THE NATIONAL ECONOMIC DEVELOPMENT OBJECTIVE

(Contd)

Rio Grande Basin, Colorado

National Objective	Problems (Public Concerns)	Components of the Objectives: Desired Goods and Services	Components of the Objectives: Preferred Resource Treatment
NED 13	Inadequate municipal water supply.	Increased municipal water supply.	Improve water storage and delivery.
NED 14	Poor housing.	Increased low cost housing.	Promote means for low cost housing.
NED 15	Lack of recreational areas and facilities.	Increased recreational facilities.	Provide more water, land and recreational facilities.
NED 16	Inadequate recreational access.	Increased recreational access.	Provide additional access to water and land for recreation.
NED 17	Insufficient timber supply to operate existing mills at capacity; Current level of timber management will not allow basin's resources to contribute their share of nation's future needs; Significant mortality in overmature and significant stagnation in immature stands.	Increased or more efficient output of forest products.	Increase timber supply.
NED 18	Fluctuating under and over utilization of recreation resources.	More efficient output of recreation opportunities.	More efficient utilization of recreation resource.

2. ENVIRONMENTAL QUALITY Objective

Today's society is concerned about the natural environment and its maintenance and enhancement as a source of present enjoyment and a heritage for future generations. Hence, a second objective is to enhance environmental quality by the management, conservation, preservation, creation, restoration or improvement of the quality of certain natural and cultural resources and ecological systems in the Rio Grande Basin. Recognition is given to the desirability of diverting a portion of the basin's resources from production of more conventional market-oriented goods and services in order to accomplish environmental objectives. Locally perceived problems falling under this objective numbered one to ten and are tabulated in Table III-4.

TABLE III-4

CORRELATION OF LOCAL PROBLEMS TO THE ENVIRONMENTAL QUALITY OBJECTIVE

Rio Grande Basin, Colorado

National Objective	Problems (Public Concerns)	Components of the Objectives	
		Desired Goods and Services	Preferred Resource Treatment
EQ 1	Wind erosion.	Preservation of the land resource base.	Decrease wind erosion in San Luis Valley.
EQ 2	Lack of recreation areas and facilities.	Preserve the quality aspects of water, land, and air.	Install recreation areas and facilities using safeguards to maintain water, land, and air in an acceptable condition.
EQ 3	Water pollution is being caused by mine drainage and agriculture runoff.	Enhancement of quality aspects of water.	Decrease mine and agricultural runoff.
EQ 4	Opportunities for scientific investigation and recreation in a wilderness setting may be significantly diminished.	Preserve wilderness opportunities.	Classify all undeveloped roadless areas (UDRA) as wilderness.
EQ 5	Decreasing big game winter range.	Preservation of wildlife.	Maintain or increase carrying capacity of big game winter range.
EQ 6	Big game migration routes are threatened by urban development.	Preservation of wildlife.	Maintain freedom of movement of big game along migration routes.
EQ 7	Inadequate access to public land for hunting and fishing purposes.	Maintain or increase fishing and hunting opportunities.	Obtain rights of way.
EQ 8	Degradation of trout habitat due to siltation of streams by road construction and timber harvest activities.	Preservation of wildlife.	Modify road building and timber harvesting activities to reduce stream siltation.
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	Preservation of biological resource.	Maintain quantity and quality of habitat of peregrine falcon greater sandhill crane, whooping crane, mexican duck, black-footed ferret, wolverine, river otter, lynx, gray wolf, grizzly bear and Rio Grande cutthroat.
EQ 10	Smoke from sawmill burners degrades air quality.	Preserve quality of air.	Decrease air pollution from sawmill burners.

RESOURCE BASE

CHAPTER IV - RESOURCE BASE

A. Resource Base

1. Geographical Location

The Rio Grande Basin Colorado is located in south central Colorado, encompassing some 4,831,000 acres (1,955,100 ha) or about 7 percent of the state. Headwaters of the Rio Grande and the Closed Basin, originating in surrounding mountains, and the San Luis Valley itself, comprise the basin. It is bounded on the west and north by mountains of the Continental Divide, on the east by the Sangre de Cristo range, and on the south by the Colorado-New Mexico state line. The Rio Grande itself originates in the extreme western end of the basin and flows in an easterly direction to the city of Del Norte, then southeasterly to Alamosa, and finally southerly, exiting the state at the Colorado-New Mexico state line.

Sangre De Cristo - Mountain Range

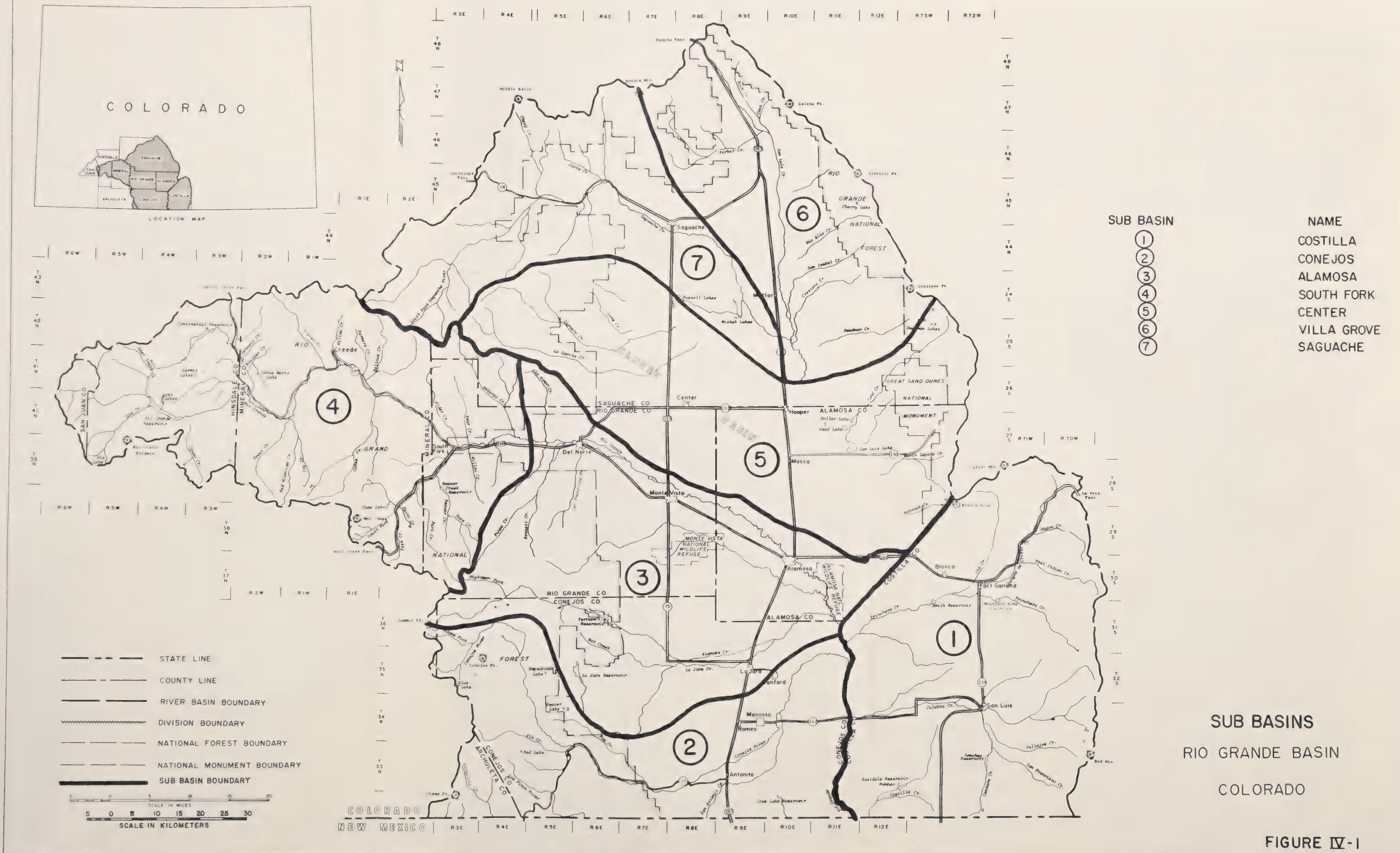
All or parts of nine counties are located in the study area: Rio Grande, Conejos, Costilla, Alamosa, Saguache, Mineral, Archuleta, San Juan, and Hinsdale counties. The valley floor, or generally that part of the Rio Grande Basin below the 8,000 feet (2,438 m) elevation, is known as the San Luis Valley. The northern part of the valley lies within the closed basin with no surface drainage outlet. This basin is separated from the Rio Grande drainage by a low lying ridge several miles (kilometers) wide.

In order to study the land and water resources, a map of the basin was divided into seven hydrologic sub basins (Figure IV-1). This enabled coordination of the land resources with its water supply. Sub basins 5, 6, and 7 comprise the Closed Basin.

2. Climate

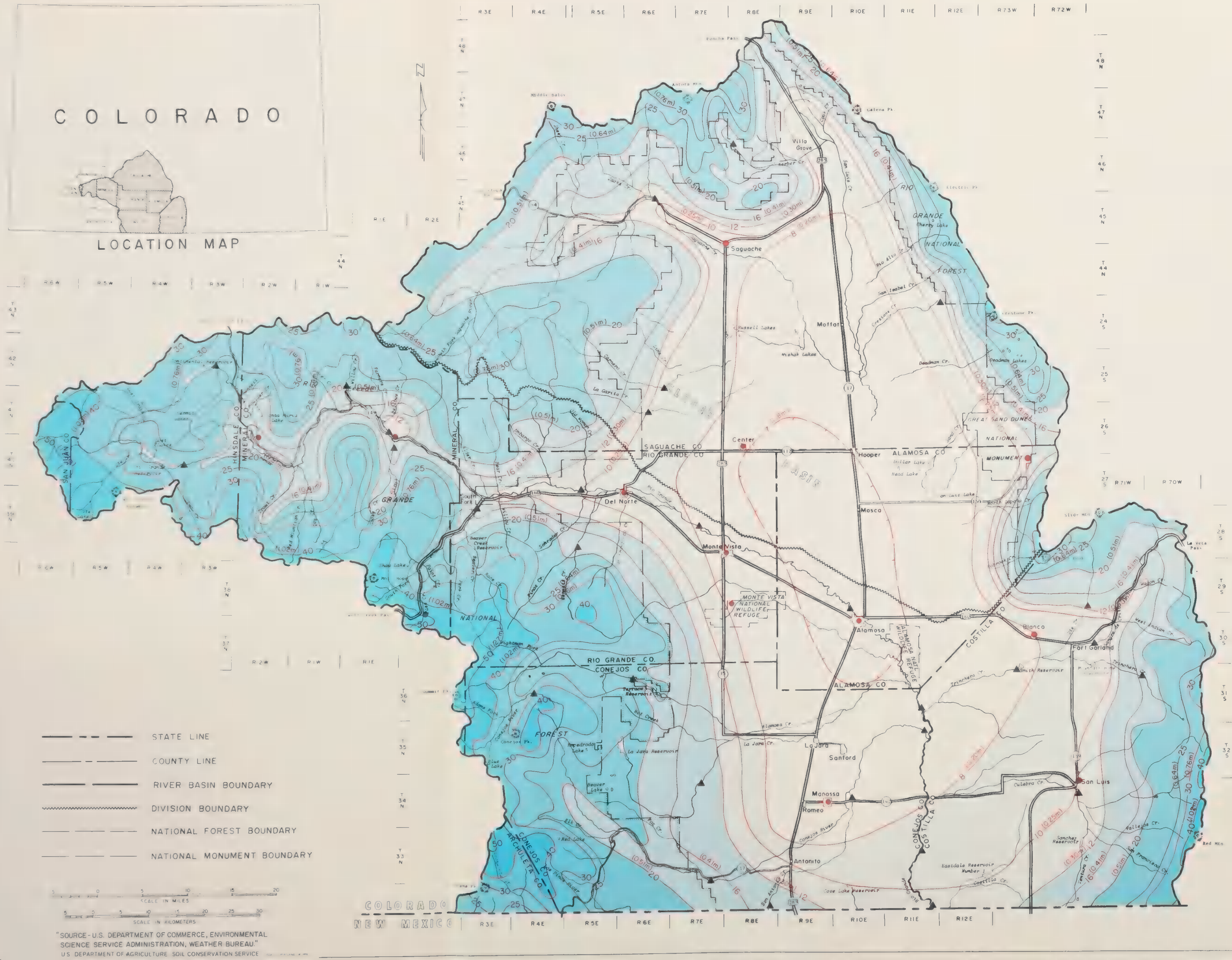
Areas in the higher elevations of the Rio Grande Basin receive relatively high precipitation, having significant water yields. Average annual precipitation varies in the foothills from 9 to 14 inches (0.23 to 0.36 m) and in the mountains from 14 to 45 inches (0.36 to 1.14 m). (See Plate 2.)

Hermit Lakes and Rio Grande Pyramid



SUB BASINS
RIO GRANDE BASIN
COLORADO

FIGURE IV-1



LEGEND

1931-60 AVERAGE ANNUAL PRECIPITATION

INCHES	METRE (m)
6 TO 8	0.15 TO 0.20
8 TO 12	0.20 TO 0.30
12 TO 20	0.30 TO 0.51
20 TO 30	0.51 TO 0.76
30 TO 40	0.76 TO 1.02
OVER 40	OVER 1.02

PRECIPITATION STATION

STREAMFLOW STATION

AVERAGE ANNUAL PRECIPITATION (BASE PERIOD 1931-1960)

RIO GRANDE BASIN COLORADO

1978

PLATE 2

Temperatures range from extremely cold to moderately hot, with low temperatures to minus 50 degrees (-45.6° C) and the warm temperatures around 90 degrees Fahrenheit (32.2° C). The San Luis Valley portion of the basin is considered to be a high mountain desert with cool summers and cold winters, most of the precipitation coming in the form of scattered summer afternoon rain showers.

The combination of high altitude and low temperatures make the growing season very short in many areas as can be noted in Table IV-1. Local air drainage systems significantly affect growing systems within very short distances so station data are of limited use except as relative indicators.

TABLE IV-1--Climatic Indications for Selected Stations
Rio Grande Basin, Colorado

	Growing Season (days/year)	Annual Mean Temperature		Average Annual Precipitation	
		(F°)	(C°)	(inches)	(m)
Alamosa	98	41.6	5.3	6.94	0.18
Center	96	41.8	5.4	7.37	0.19
Del Norte	114	43.1	6.2	9.41	0.24
Hermit Station	11	34.6	1.4	15.8	0.40
Manassa	90	42.3	5.7	7.38	0.19
Monte Vista	72	41.6	5.3	7.25	0.18
Saguache	106	43.1	6.2	8.49	0.22

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3. Physiography

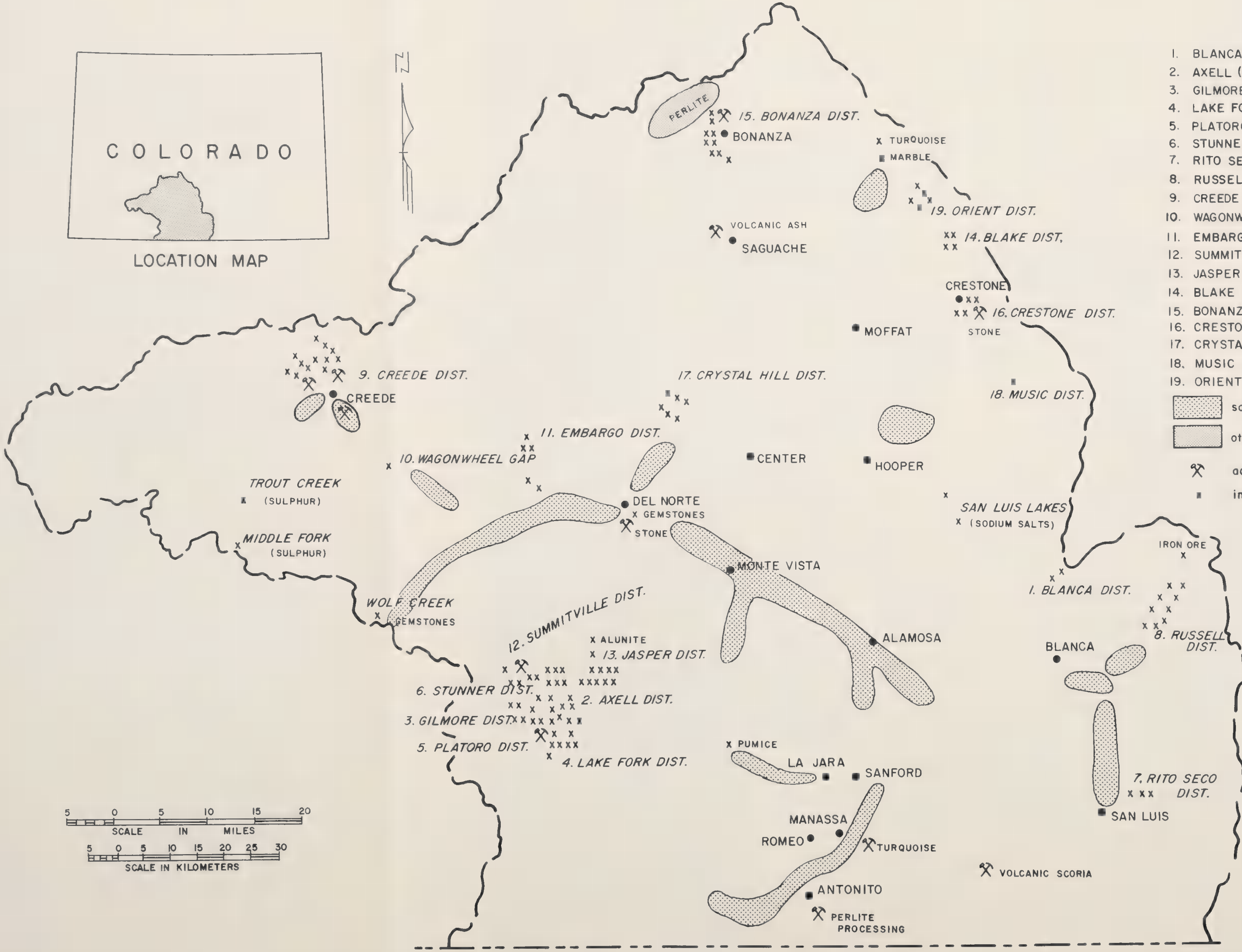
The Sangre de Cristo Mountains, the east boundary of the basin, have several peaks with elevations in excess of 14,000 feet (4,267 m) above sea level. The west boundary is formed by the San Juan Mountains also attaining elevations in excess of 14,000 feet (4,267 m). The floor which is relatively flat floor ranges in altitude from approximately 7,500 feet (2,286 m) in the sump area of the Closed Basin in the north to more than 8,000 feet (2,438 m) on the alluvial fans. The San Luis Hills, a series of low basalt capped hills and mesas that rise 500 to 1,000 feet (152 to 305 m) above the basin, lie in the south portion near the community of San Luis. Active sand dunes, located in the Great Sand Dunes National Monument, contain a relief of approximately 1,000 feet (305 m).

Elephant Mountain - Elevation 12,828 ft
(3910m) near Summitville, Colorado

4. Mineral Resources

The San Juan and Sangre de Cristo mountain ranges have long been a major focus of mining activity. The most significant area was found around Creede, but several smaller districts are scattered throughout the basin as can be seen in Figure IV-2. Mining is relatively insignificant regionally as an employer and in value of production, but is important in some localities. Production varies widely from year to year as does the economic and employment impact of the industry.

Metallic ores, particularly silver and lead, are the most important products in terms of value. Volcanic scoria, sand and gravel are also major components of the basin's mining industry. Peat, sand and gravel, and turquoise are sold locally. All other mineral production is exported out of the basin for final processing and utilization.



MINING ACTIVITY

1. BLANCA (gold)
2. AXELL (gold, silver)
3. GILMORE (gold, silver, copper, lead)
4. LAKE FORK (gold, silver, copper, lead)
5. PLATORO (gold, silver, copper, lead)
6. STUNNER (gold, silver, copper, lead)
7. RITO SECO (gold)
8. RUSSELL (gold)
9. CREEDE (silver, lead, gold, zinc, copper, gemstones, clay)
10. WAGONWHEEL GAP (fluorspar)
11. EMBARGO (gold, silver, lead, copper, gemstones)
12. SUMMITVILLE (copper, gold, silver, lead)
13. JASPER (gold, silver)
14. BLAKE (gold, silver, copper, gemstones)
15. BONANZA (gold, lead, copper, silver, zink, gemstones, uranium)
16. CRESTONE (gold, silver, copper, lead, gemstones)
17. CRYSTAL HILL (gold, silver, gemstones)
18. MUSIC (gold, silver, lead, copper, gemstones)
19. ORIENT (iron ore)

sand & gravel deposits
other deposits
active operations
inactive operations

MINING AND MINERAL RESOURCE AREAS

RIO GRANDE BASIN
COLORADO

FIGURE IV-2

USDA-SCS-PORTLAND, OR. 1978

5. Land Surface Characteristics

While minerals are considered subsurface resources here, this section deals with that part of the earth's upper surface perceived as embracing those land resources and use patterns usually associated with the visible aspects of the environment. These include features of the earth's upper crust such as soils, surface cover, land use and land ownership.

a. Soils

Broad characteristics and relationships of soils can be used to interpret the potential of land for agricultural, grazing, recreational, forestry, industrial uses, etc. Problems related to erosion, salts and alkali, sediment yield, land use and future development are also intertwined with the basin's soil types and their distribution as shown on Plate 3. More detailed descriptions of the soils are presented in Appendix A, with only a brief account given below.

The soils depicted as green are generally on timbered mountain slopes, high plateaus, mesas, sparsely vegetated escarpments and rock outcrops, ranging in elevations from 7,500 to 11,500 feet. (2,286 to 3,505 m). Some areas are grazed, but main uses involve recreation, wildlife habitat, water supply and timber production.

Soils shown in blue usually occur on alluvial fans, terraces, and floodplains at elevations from 7,500 to 9,000 feet (2,286 to 2,743 m). Native vegetation is a mixture of salt-tolerant shrubs and grasses used for grazing and big game winter range. When irrigated, these soils are suitable for cropland and pasture. Some of these soils are affected by salts and alkali which seriously reduce crop yields and make the soil unsuitable for cultivation. The alkali and salt conditions have been brought about by the high water table that underlies these soils. They generally can be reclaimed or improved by drainage, leaching and/or good water management.

Yellow areas show low alluvial fans, terraces and flood plains on the basin floor at an elevation of about 7,500 feet (2,286 m). Vegetation and use of these soils are almost entirely irrigated, native vegetation practically nonexistent. Some of these soils are affected by salts and alkali which seriously reduce crop yields and make the soil unsuitable for cultivation. The alkali and salt conditions have been brought about by the high water table that underlies these soils. They generally can be reclaimed or improved by drainage with a suitable outlet, leaching and/or good water management.

Soils shown as orange are used almost entirely as rangelands, occupying ridges, dunes and flood plains up to 8,000 feet (2,438 m) and supporting native grasses and shrubs.

Limited grazing occurs on areas shown as white. The soils are located at elevations from 11,000 to 14,500 feet (3,353 to 4,420 m). Alpine ecosystems consist of mountain peaks, rock slides and outcrops, are normally used for wildlife, recreation and watershed benefits.

Soils shown in brown have a wide spectrum of uses, elevations and occurrences. They are on flood plains and alluvial fans at 7,500 feet (2,286 m), where irrigated croplands and pastures dominate, to high mountain slopes at 11,500 feet (3,505 m), where uses are timber production, recreation, grazing and wildlife. Middle elevations support open woodlands of pinyon-juniper and grazing important not only for domestic livestock but also as winter range for deer and elk. Development in the form of permanent residences, cabins, and summer homes is occurring on some of these soils at lower and middle elevations.

The small area in pink is an expanse of inland sand dunes formed by winds blowing sand across the basin floor and depositing it at the base of the Sangre de Cristo mountains. Vegetation does not have the opportunity to establish on the dunes because these sands drift all the time. Their main attraction is for recreation.

b. Ground Cover

Vegetative cover in the Rio Grande Basin varies from dense forests in favorable mountain areas to open scrub forests at lower, dry elevations and from highly productive irrigated lands to arid, barren wastelands. Only a general description of the cover types is displayed in Plate 4. More precise information is given in Appendix B. Plant cover, in association with other physiographical features, is significant in that it is a prominent indicator of potential land use suitability and capability. As presented here, the plant cover types are basically ecological units or associations.

LEGEND

GROUP I — ALFISOLS

BORALFS

- Typic Cryoboralfs, skeletal - Rock Outcrop: sloping to steep

GROUP II — ARIDISOLS

ARGIDS

- 5 — Typic Haplargids, loamy - Typic Torriorthents, skeletal: nearly level and gently sloping
- 7 — Borollic Haplargids - Borollic Calciorthids: loamy; nearly level to sloping
- 17 — Typic Natrargids, clayey - Typic Torripsamments: nearly level to moderately steep

ORTHIDS

- 19 — Typic Calciorthids, skeletal - Borollic Calciorthids, loamy: nearly level to sloping
- 22 — Borollic Lithic Camborthids, skeletal - Rock Outcrop; gently sloping to steep

GROUP III — ENTISOLS

AQUENTS

- Typic Psammaquents - Typic Natrargids, loamy - Aquic Natrargids, loamy: nearly level

ORTHENTS

- Typic Ustorthents: skeletal; nearly level

GROUP IV

PSAMMENTS

- Typic Torripsamments: nearly level to steep

GROUP V — INCEPTISOLS

UMBREPTS

- 47 — Pergelic Cryumbrepts, skeletal - Pergelic Cryochrepts, skeletal - Rock Outcrop: sloping to steep

GROUP VI — MOLLISOLS

AQUOLLS

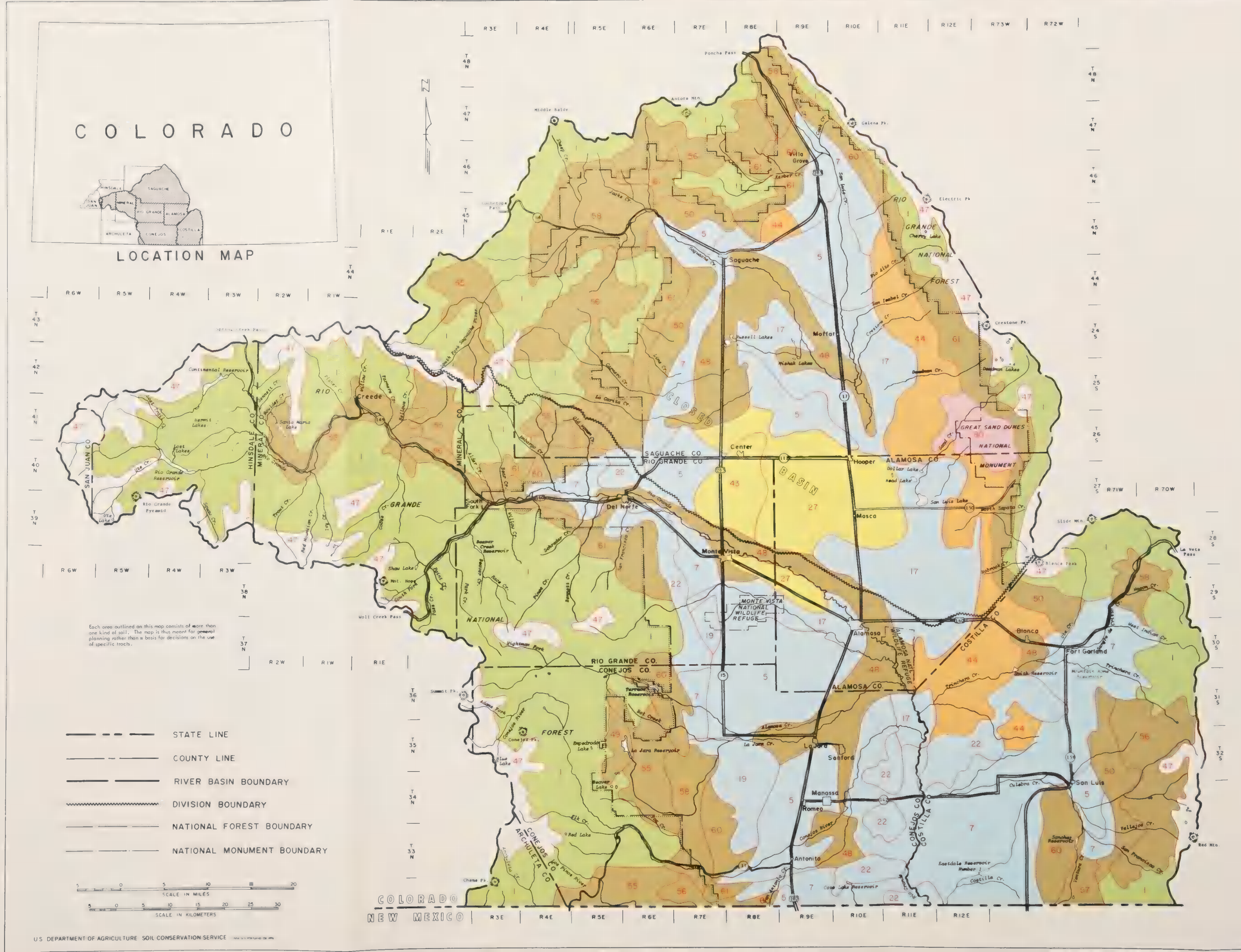
- Typic Argiaquolls, loamy - Aeric Halaquepts, clayey - Typic Haplaquolls, loamy: nearly level
- Typic Cryaquolls - Argic Cryaquolls, loamy - Cumulic Cryaquolls: loamy; nearly level and gently sloping

BOROLLS

- Aridic Argiborolls - Lithic Argiborolls: skeletal; sloping to steep
- Typic Cryoborolls, loamy - Rock Outcrop: sloping to steep
- Typic Cryoborolls, clayey - Typic Cryoboralfs, skeletal: moderately steep and steep
- Typic Cryoborolls - Typic Cryothents : clayey; sloping to steep
- Argic Cryoborolls - Typic Cryoborolls: loamy; gently sloping to steep
- Aridic Haploborolls, loamy - Torriorthentic Haploborolls, loamy - Aridic Argiborolls, clayey: gently sloping to steep
- Lithic Haploborolls, skeletal - Rock Outcrop: moderately steep and steep

GROUP VII — LAND TYPE

- Dune Land



GENERAL SOIL MAP
RIO GRANDE BASIN
COLORADO
1978

PLATE 3

Rio Grande National Forest at
Lookout Mountain

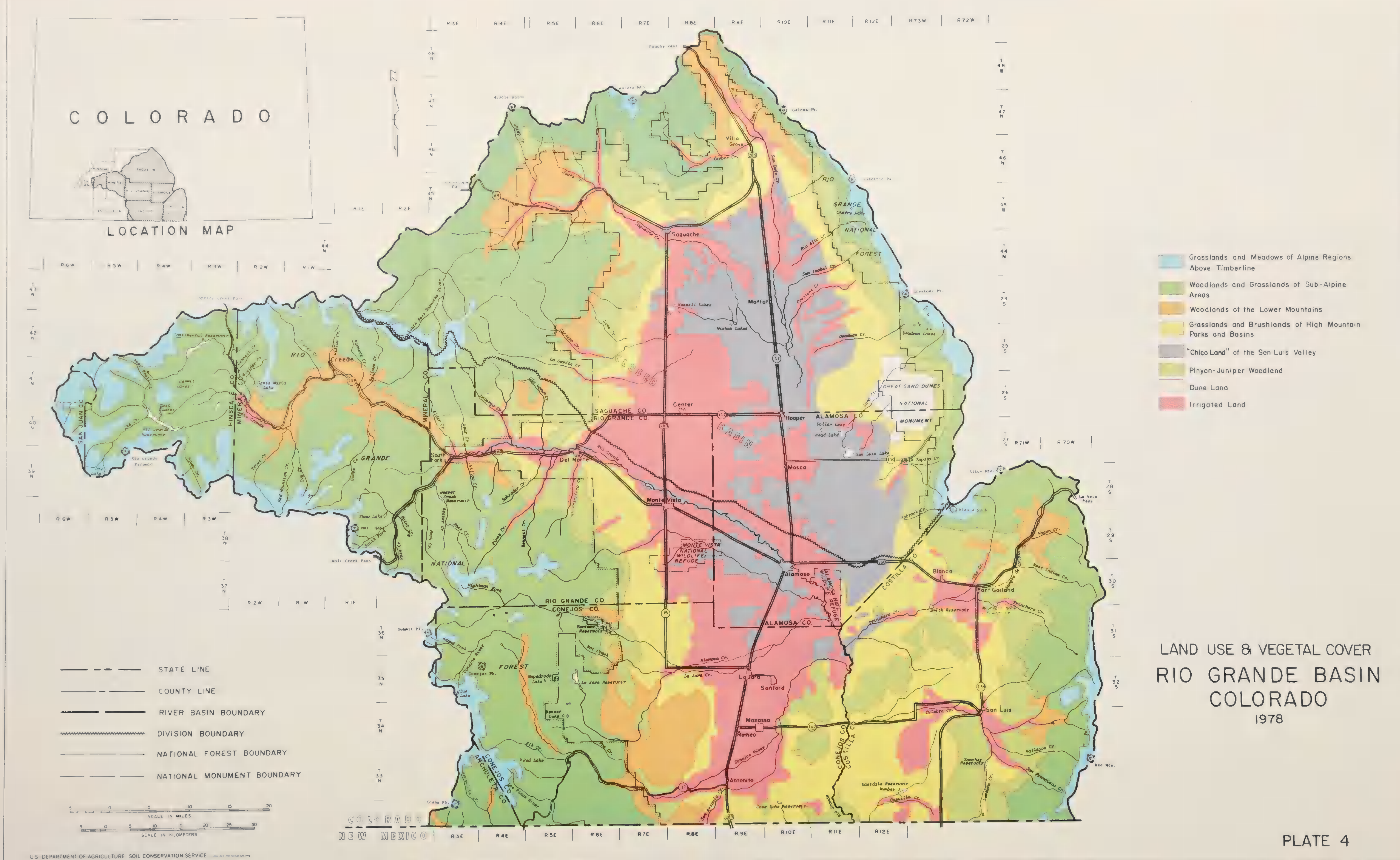
(1) Grasslands and Meadows of Alpine Regions Above Timberline

Beginning at the highest elevations above 11,500 feet (3,505 m) alpine (blue) cover generally consist of fragile plant communities of sedges, grasses, forbs and shrubs interspersed with barren areas of rock slides, snow fields and glaciers.

Summit Peak and Montezuma Peak on the
Continental Divide

(2) Forest

Forest and grasslands of sub-alpine areas (green) are limited at high elevations by severity of climate and at low elevations by insufficient precipitation. Higher elevations support sub-alpine areas dominated by Engelmann spruce, sub-alpine fir, and aspen with a sparse understory of sedges, grasses and low shrubs. Below the sub-alpine areas begins the forest of the lower mountains (orange) characterized by Douglas fir, lodgepole pine, aspen and open stands of ponderosa pine, usually with an understory of grasses, forbs and shrubs.


COLORADO
LOCATION MAP
Grasslands and Meadows of Alpine Regions Above Timberline
Woodlands and Grasslands of Sub-Alpine Areas
Woodlands of the Lower Mountains
Grasslands and Brushlands of High Mountain Parks and Basins
"Chico Land" of the San Luis Valley
Pinyon-Juniper Woodland
Dune Land
Irrigated Land
STATE LINE
COUNTY LINE
RIVER BASIN BOUNDARY
DIVISION BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL MONUMENT BOUNDARY
SCALE IN MILES
SCALE IN KILOMETERS
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE
LAND USE & VEGETAL COVER
RIO GRANDE BASIN
COLORADO
1978
PLATE 4
RIO GRANDE NATIONAL FOREST
CLOSED BASIN
GREAT SAND DUNES NATIONAL MONUMENT
MONTE VISTA NATIONAL WILDLIFE REFUGE
ALAMOSA NAT. WILDLIFE REFUGE
SAGUACHE CO
RIO GRANDE CO
ALAMOSA CO
CONEJOS CO
COSTILLA CO
MINERAL CO
HINSDALE CO
SAN JUAN CO
ARCHULETA CO
COLORADO
NEW MEXICO
Saguache
Villa Grove
Moffat
Center
Hooper
Mosca
Del Norte
South Fork
Creede
Monte Vista
Alamosa
Blanca
Fort Garland
La Jara
Sanford
Manassa
Romeo
Antonito
San Luis

The pinyon-juniper type (light green) occurs between 8,000 and 9,000 feet (2,438 and 2,743 m) with an understory of grasses, forbs, and shrubs. Grasslands and brushlands of high mountain parks and basins (yellow), a transition type between forest and other vegetation types, is comprised of such shrubs as big sagebrush, oakbrush, skunkbush, mountain mahogany, currant-rose, rock spirea, snowberry and service berry, associated with various grasses, sedges, and forbs.

(3) Range

For grasslands and brushlands of high mountain parks and basins (yellow) the vegetation varies from unbroken expanses of grasses to scattered pinyon and/or juniper to areas of big sagebrush, rabbitbrush or winterfat, wheatgrass, needlegrass and bluegrass.

Rangeland near Center, Colorado

The "Chico Land" of the San Luis Valley (purple) are typical of the broad central floor of the basin. Vegetation consists of greasewood, rabbitbrush, four-wing saltbush, saltgrass, alkali sacaton, wheatgrass, sedges and rushes.

(4) Cropland

Practically the entire basin would be unsuitable for farm crop production without (irrigation) artifically applying water. Irrigated cropland (red) has made agriculture a major component of the basin's economy. Crops that do well with irrigation are barley, wheat, oats, alfalfa, potatoes, vegetables, grass and small grain hay.

Potatoes in Monte Vista area

(5) Duneland

The giant dunes, (white) rising as much as 1,000 feet (305 m) above the basin floor, consist of constantly shifting sand. This barren but very scenic area has severe limitation for common land uses, but it is very unique and valuable for the specific recreation to which it has been reserved as a National Monument.

Duneland northeast of Alamosa, Colorado

c. Land Utilization

Cropland (90% irrigated) comprises some 9 percent of the basin and is found primarily on the basin floor. (See Table IV-2). An additional 43 percent of the basin consists of irrigated pasture land. Together these irrigated lands account for only 13.3 percent of the total land area, but produce high-value grains, vegetables, hay and pastures (See Figure IV-3).

Grazing (41%) is the major land user in the basin. Grazing is also an integral use of many forest lands, wilderness and roadless areas. Consequently, while the classification in Table IV-2 presents insight to the basin's land uses, one must remain aware that much overlap can occur, especially on multiple use type lands.

Meadow pasture along Conejos River

TABLE IV-2

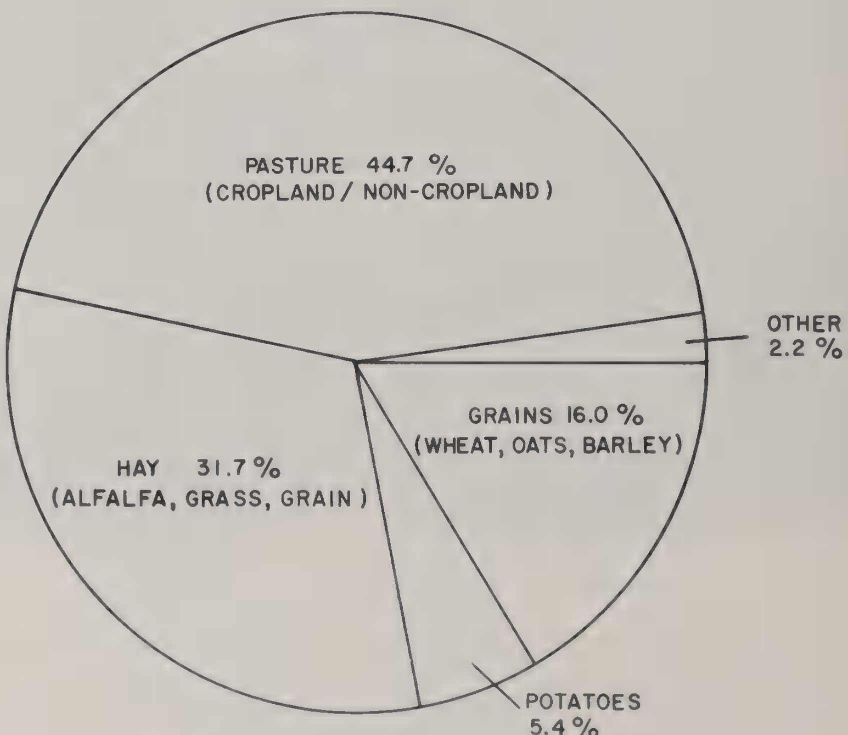
MAJOR LAND UTILIZATION SECTORS
Rio Grande Basin, Colorado

	Acres		Hectares	Percent of Basin Area
Cropland	436,885		176,807	9.1
Irrigated	(403,815)	(92%)	(163,424)	8.4
Idle	(33,070)	(8%)	(13,383)	0.7
Irrigated Pasture	205,775		83,277	4.2
Range	1,980,234		801,401	40.9
Forest	1,394,393		564,311	28.9
Commercial	(907,926)	(65%)	(367,438)	18.9
Noncommercial	(486,467)	(35%)	(196,873)	10.1
Wilderness	149,609		60,547	3.1
Roadless Area 1/	463,920		187,748	9.6
Other 2/	200,478		81,133	4.2
TOTAL	4,831,294		1,955,225	100

1/ Includes undifferent forest, range and "other" categories.

2/ Includes water, national monument and wildlife refuges, recreation, urban areas, etc.

Sheep grazing irrigated hayland.



Primary Use of Irrigated Lands
Rio Grande Basin, Colorado

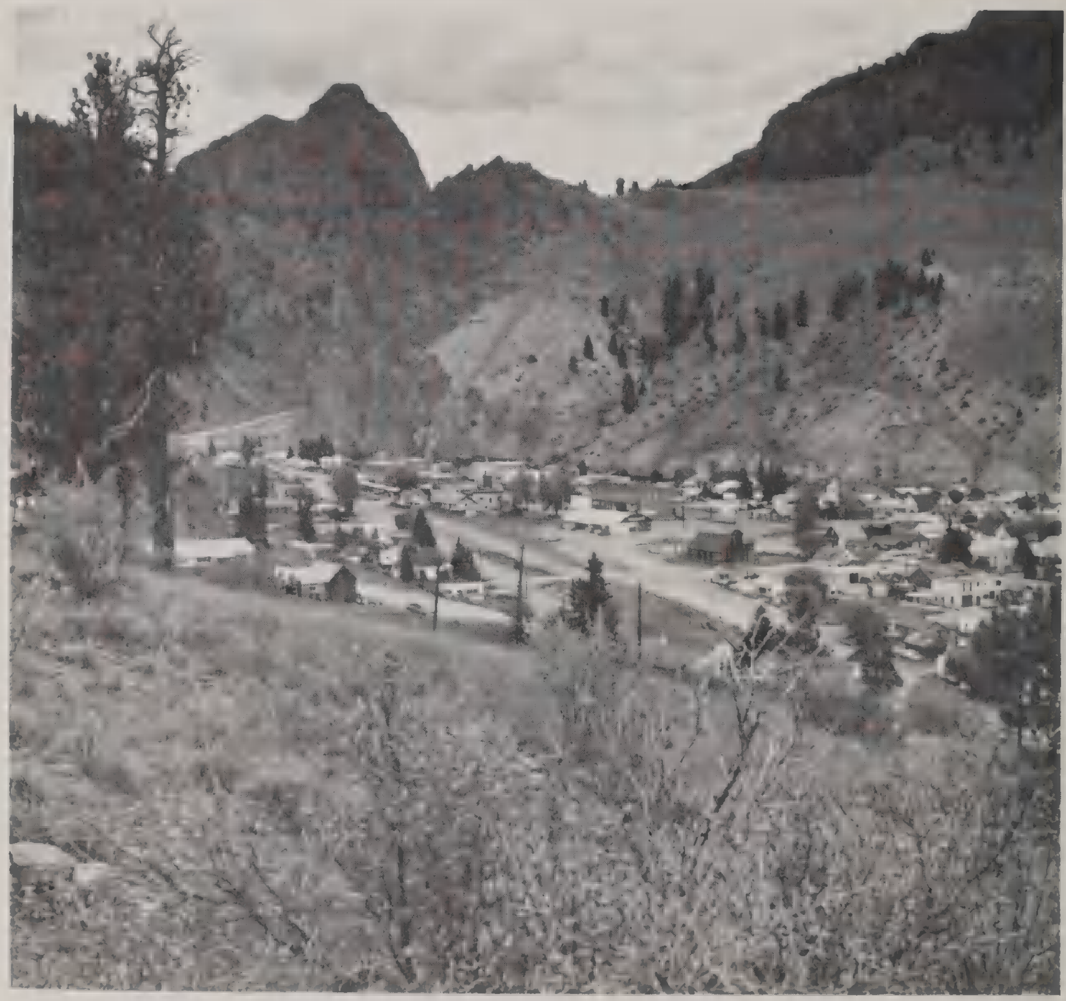
FIGURE IV-3

A similar situation is present when considering forest, wilderness and roadless categories. Total forest land shown in Table IV-2 accounts for 29 percent of the basin. Although much forest is included in the La Garita and Weminuche Wilderness areas (3 percent of the basin), these units are legislatively protected from any development. Roadless areas, on the other hand, could eventually return to multiple use or attain wilderness status, the decision lying with Congress alone. But while awaiting final status, further development on these lands is prohibited. While these areas encompass various vegetative types, about 150,000 acres (6,071 ha)--one-third of their composite area, support commercial forests. Grazing is also an important use of many of these areas.

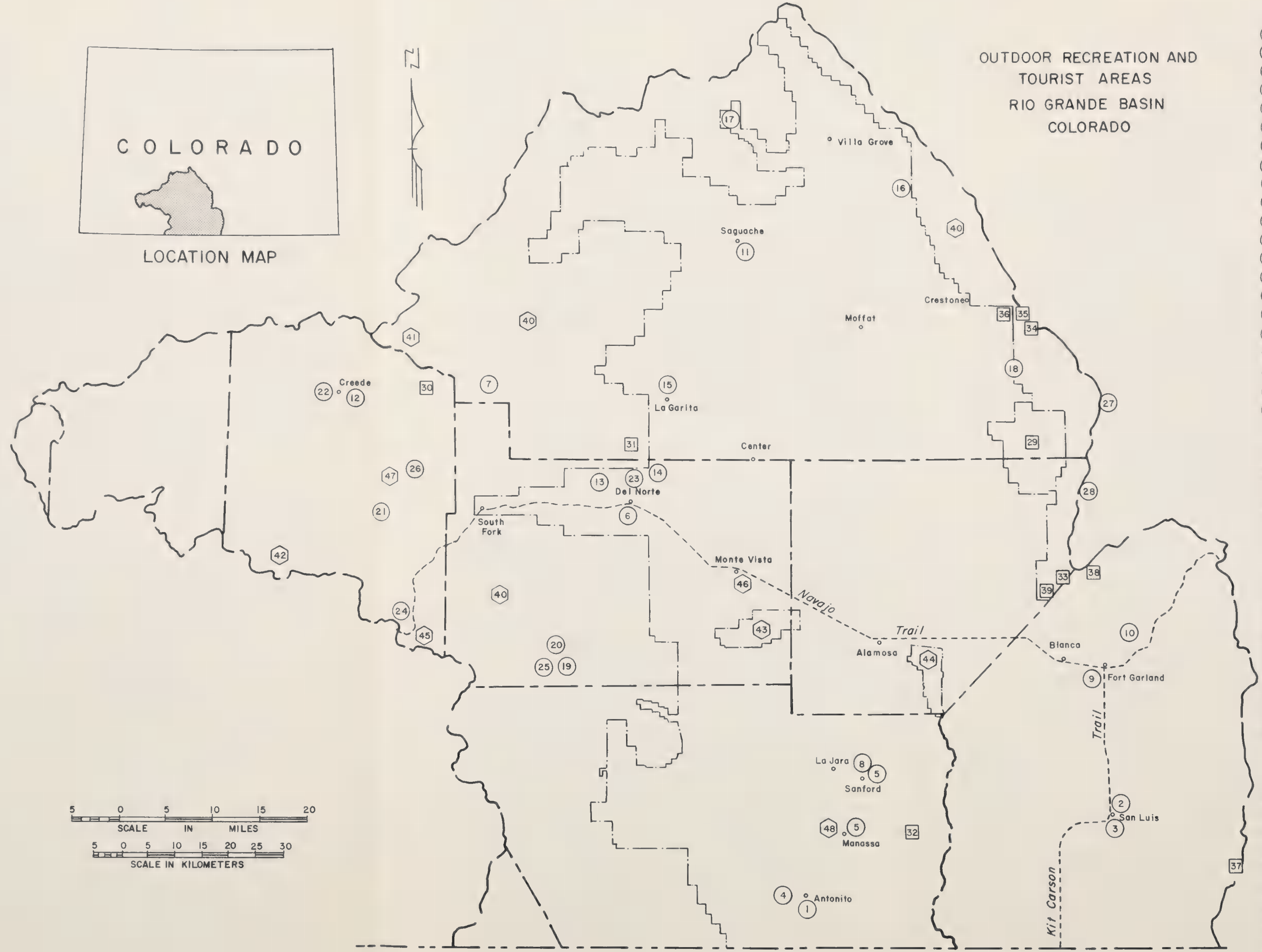
The remaining 4 percent has a variety of uses, most significant are the Great Sand Dunes National Monument (0.8%), National Wildlife Refuge (0.5%), nonclassed farmland (1.2%), urban areas (0.1%), and recreation lands (0.1%).

Railroad engine used on narrow gauge railroad.

Recreational use of lands can be nearly all-encompassing if one considers esthetic values, wherein land use activities themselves become assets by providing variation in landscape scenes. Some lands have been set aside strictly for recreation because of their historic and cultural values. In addition to those areas already mentioned above, Figure IV-4 includes other public and private recreation areas found in the basin. More detailed descriptions of areas are contained in Appendix C.



Creede, Colorado - Mining and Tourism



HISTORICAL VALUES

1. CUMBRES & TOLTEC SCENIC RAILROAD - ANTONITO
2. OLDEST TOWN IN COLORADO - FOUNDED IN 1851 - SAN LUIS
3. SAN LUIS PEOPLE'S DITCH - SAN LUIS
4. OLDEST CHURCH IN COLORADO - CONEJOS
5. MORMAN PIONEER DAYS CELEBRATION - SANFORD & MANASSA
6. BARLOW - SANDERSON STAGE STATION - DEL NORTE
7. FREMONT'S CAMP - SOUTH FORK
8. PIKE'S STOCKADE - SANFORD
9. FORT GARLAND - FORT GARLAND
10. FORT MASSACHUSETTS - FORT GARLAND
11. SAGUACHE MUSEUM - SAGUACHE
12. CREEDE MINING DISTRICT - CREEDE
13. INDIAN HEAD - DEL NORTE
14. WAGON TRACKS - LA GARITA
15. LA GARITA CHURCH - LA GARITA
16. ORIENT (HISTORIC MINE) - VILLA GROVE
17. BONANZA (GHOST TOWN) - VILLA GROVE
18. LIBERTY (GHOST TOWN) - CRESTONE
19. JASPER (GHOST TOWN) - DEL NORTE
20. SUMMITVILLE (GHOST TOWN) - DEL NORTE
21. SPAR CITY (GHOST TOWN) - CREEDE
22. BACHELOR (GHOST TOWN) - CREEDE
23. LOMA (GHOST TOWN) - DEL NORTE
24. WOLF CREEK PASS - SOUTH FORK
25. ELWOOD PASS - DEL NORTE
26. WAGON WHEEL GAP - WAGON WHEEL GAP
27. MEDANO PASS - MOSCA
28. MOSCA PASS - MOSCA

ARCHEOLOGICAL VALUES

29. GREAT SAND DUNES NATIONAL MONUMENT - MOSCA
30. WHEELER GEOLOGIC AREA - CREEDE
31. NATURAL ARCHES - DEL NORTE
32. KING'S TURQUOISE MINE - MANASSA
33. BLANCA PEAK (14,345') - (4372 m) - BLANCA
34. CRESTONE NEEDLE (14,197') - (4327m) - CRESTONE
35. CRESTONE PEAK (14,294') - (4357m) - CRESTONE
36. KIT CARSON PEAK (14,165') - (4317m) - CRESTONE
37. CULEBRA PEAK (14,069') - (4288m) - SAN LUIS
38. MOUNT LINDSEY (14,042') - (4280m) - BLANCA
39. LITTLE BEAR PEAK (14,037') - (4278m) - BLANCA

MAJOR RECREATION ATTRACTIONS

40. RIO GRANDE NATIONAL FOREST
41. LA GARITA WILDERNESS AREA - CREEDE
42. WEMINUCHA WILDERNESS AREA - CREEDE
43. MONTE VISTA NATIONAL WILDLIFE REFUGE - MONTE VISTA
44. ALAMOSA NATIONAL WILDLIFE REFUGE - ALAMOSA
45. WOLF CREEK SKI AREA - SOUTH FORK
46. SKI HI STAMPEDE - MONTE VISTA
47. RIO GRANDE RAFT RACES - CREEDE - DEL NORTE
48. BIRTHPLACE OF BOXER JACK DEMPSEY - MANASSA

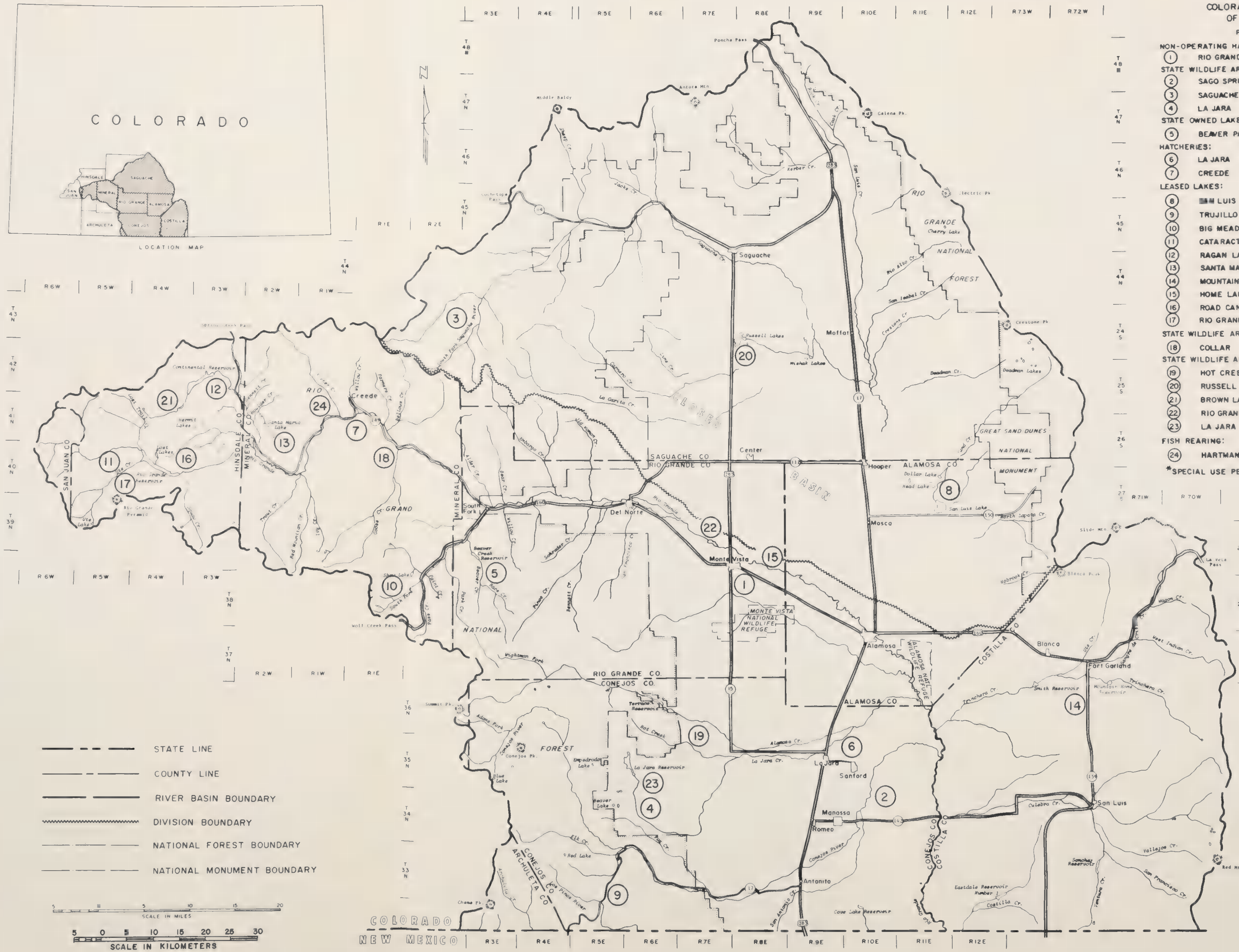
USDA-SCS-PORTLAND, OR. 1978

FIGURE IV-4

COLORADO DIVISION OF WILDLIFE AND COLORADO DIVISION OF PARK AND OUTDOOR RECREATION PROPERTIES

	PROPERTY	ACRES	HECTARES
NON-OPERATING HATCHERIES:			
1	RIO GRANDE	30.8	12.5
STATE WILDLIFE AREAS (BIG GAME):			
2	SAGO SPRINGS	640.0	259.0
3	SAGUACHE PARK	220.0	89.0
4	LA JARA	2808.2	1136.5
STATE OWNED LAKES:			
5	BEAVER PARK RES. (LEASE)	80.0	32.4
HATCHERIES:			
6	LA JARA	11.25	4.6
7	CREEDE	21.73	8.8
LEASED LAKES:			
8	SAN LUIS LAKES	350.0	141.6
9	TRUJILLO MEADOWS RES. USFS*	70.0	28.3
10	BIG MEADOWS USFS*	114.6	46.4
11	CATARACT LAKES USFS*	40.0	16.2
12	RAGAN LAKE USFS*	61.0	24.7
13	SANTA MARIA 1000 A.F. (CON. POOL) (1,233,500 m^3)		
14	MOUNTAIN HOME & SMITH RES.	2925.0	1183.7
15	HOME LAKE	45.0	18.2
16	ROAD CANYON NO. 1 & NO. 2 USFS	112.92 & 179.6	45.7 & 72.7
17	RIO GRANDE RES. 2000 A.F. (CON. POOL) (2,467,000 m^3)	242.0	97.9
STATE WILDLIFE AREAS - COMB. (BIG - SMALL GAME):			
18	COLLAR 120 AC. EASE. (48.6 ha)	773.81	297.0
STATE WILDLIFE AREAS - COMB. (GAME - FISH):			
19	HOT CREEK	1974.7	799.2
20	RUSSELL LAKES	160.0	64.8
21	BROWN LAKES	520.0	210.4
22	RIO GRANDE	935.48	378.6
23	LA JARA RES.	2568.87	1039.6
FISH REARING:			
24	HARTMAN BROOD FISH STATION	30.0	12.1

*SPECIAL USE PERMIT WITH FOREST SERVICE



MAJOR FISH, WILDLIFE AND ASSOCIATED RECREATION AREAS

RIO GRANDE BASIN

COLORADO

FIGURE IV-5

USDA-SCS-PORTLAND, OR. 1978

BIG GAME WINTER RANGE AND MIGRATION ROUTES
RIO GRANDE BASIN
COLORADO
1977

FIGURE IV-6

USDA-SCS-PORTLAND, OR. 1978

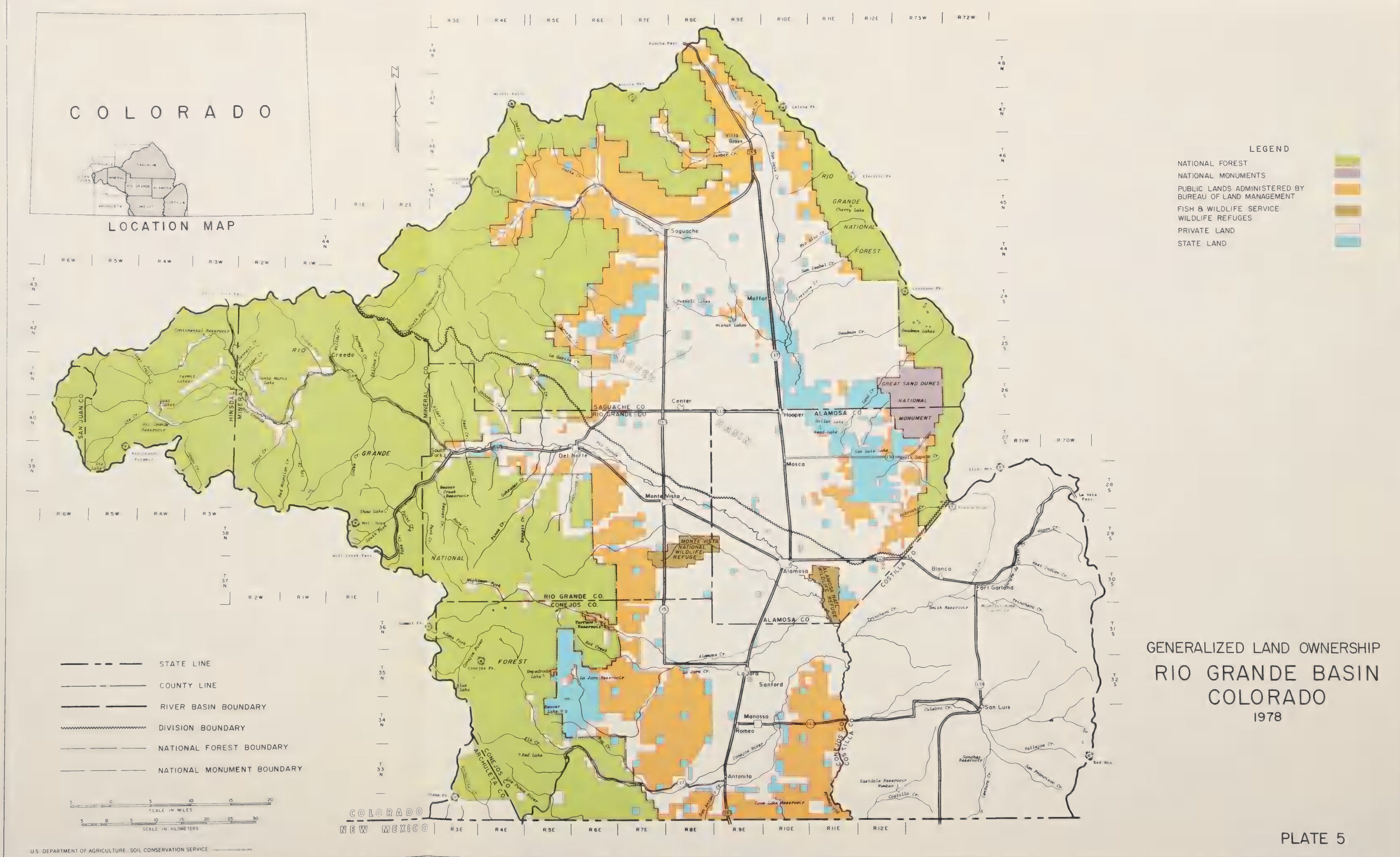

COLORADO
LOCATION MAP
LEGEND
NATIONAL FOREST
NATIONAL MONUMENTS
PUBLIC LANDS ADMINISTERED BY BUREAU OF LAND MANAGEMENT
FISH & WILDLIFE SERVICE WILDLIFE REFUGES
PRIVATE LAND
STATE LAND
STATE LINE
COUNTY LINE
RIVER BASIN BOUNDARY
DIVISION BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL MONUMENT BOUNDARY
SCALE IN MILES
SCALE IN KILOMETERS
GREAT SAND DUNES NATIONAL MONUMENT
MONTE VISTA NATIONAL WILDLIFE REFUGE
RIO GRANDE NATIONAL FOREST
SAGUACHE CO
RIO GRANDE CO
ALAMOSA CO
CONEJOS CO
COSTILLA CO
MINERAL CO
HINSDALE CO
SAN JUAN CO
ARCHULETA CO
COLORADO
NEW MEXICO
Saguache
Villa Grove
Moffat
Center
Hooper
Mosca
Del Norte
South Fork
Creede
Monte Vista
Alamosa
Blanca
Fort Garland
La Jara
Sanford
Manassa
Romeo
Antonito
San Luis
GENERALIZED LAND OWNERSHIP
RIO GRANDE BASIN
COLORADO
1978
PLATE 5
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

TABLE IV-3 - LAND OWNERSHIP BY COUNTY - 1977

(In Acres) (Hectares)

Rio Grande Basin, Colorado

	Private	(ha)	Federal Land: USFS 3/	(ha)	BLM 4/	(ha)	NPS 5/	(ha)	USF&W 6/	(ha)	State Land: Land Board 7/	(ha)	Division of Wildlife 8/	(ha)	Other 1/	(ha)	Total in Basin 2/	(ha)
Alamosa	292,700	118,456	28,100	11,372	44,000	17,807	13,480	5,455	10,900	4,411	56,500	22,866	0	0	11,900	4,816	457,580	185,183
Archuleta	25,100	10,158	22,800	9,227	0	0	0	0	0	0	0	0	0	0	0	0	47,900	19,385
Conejos	260,200	105,303	294,900	119,346	185,500	75,072	0	0	0	0	55,700	22,542	6,063	2,454	10,100	4,087	812,463	328,804
Costilla	744,900	301,461	0	0	0	0	0	0	142	57	0	0	0	0	12,700	5,140	757,742	306,658
Hinsdale	3,500	1,416	202,100	81,790	0	0	0	0	0	0	0	0	520	210	700	283	206,820 3/	83,700
Mineral	49,300	19,952	386,300	156,336	0	0	0	0	0	0	0	0	602	244	1,700	688	437,902	177,219
Rio Grande	221,40	89,601	269,500	109,067	54,000	21,854	0	0	12,300	4,978	13,000	5,261	1,132	458	9,200	3,723	580,532	234,941
Saguache	525,900	212,832	622,600	251,966	232,500	94,093	23,336	9,444	0	0	90,300	36,544	619	251	11,000	4,452	1,506,255	609,581
San Juan	200	81	23,900	9,672	0	0	0	0	0	0	0	0	0	0	0	0	24,100 3/	9,753
	2,123,200	859,259	1,850,200	748,776	516,000	208,825	36,816	14,899	23,342	9,447	215,500	87,213	8,936	3,616	57,300	23,189	4,831,294	1,955,224

1/ Includes state and county highways, and municipal lands. Road mileage x right-of-way + urban acres from LUC.
2/ Includes both land and water areas. . . CNI (watersheds) 1966, . . . County legal acreages.
3/ Acreages obtained from Bruce Benninghoff, USFS, Denver. National Forest 1973 Area Report, File 1380.
4/ Acreages obtained from Gene Vecchia, BLM, Alamosa.
5/ Total from Jim Carrico, Park Superintendent, Dunes Natl. Monument, Alamosa.
6/ Total acreage from Pete Bryant...Problems & Needs Public Meeting; Breakdown to county. Estimated from 1/2" mile county land ownership maps.
7/ County acres obtained from A. Sabatini, State Land Board. Adjusted to Basin boundaries.
8/ County acres from Division of Wildlife, Dave Lemons.

6. Water Resources

The average annual precipitation varies from 7 inches (0.18 m) in the San Luis Valley to 45 inches (1.14 m) in the mountains, therefore, the water resource and its distribution are undoubtedly a critical issue. This report views the resource from the surface and underground aspects.

a. Surface Waters

Surface water resources in the basin consist of rivers, creeks, lakes, reservoirs and interbasin diversion.

Surface Runoff - The Rio Grande at B.A.R. Cattle Company Ranch

(1) Streams

Overall streamflow depends mainly on snow of the San Juan and Sangre de Cristo Mountains. These mountains contribute

1.577 million acre-feet (1,945 million m^3) average annual water supply to the basin. This amount excludes any precipitation occurring on the basin floor.

Streamflow volume and other specific data at selected gaging stations for major streams are given in Table IV-4.

Many of the streams periodically become dry river beds or nearly so. The seasonal variation of streamflow is indicated graphically by Figure IV-7. It shows peak flows in the early summer and low discharges which occur in late summer at peak demand for irrigation water. Plate 6 gives further insight to the average annual magnitude and geographic distribution of the surface water supply.

(2) Lakes and Reservoirs

Lakes and reservoirs in the basin serve an important function of controlling natural runoff. Runoff from snowmelt generally peaks during the month of May and early June, but peak demand for water generally occurs in July and August. Storage is used to meet part of the demand. These reservoirs are not large enough to meet all the late season demands.

Table IV-5 shows a listing of reservoirs with storage capabilities. The larger reservoirs have the capacity to carry over stored water from high runoff years to drought years. Capacities shown in Table IV-5 do not reflect water supply, but simply a capability to regulate seasonal and annual runoff. Use of these bodies of water is predominantly for irrigation. In addition, some also serve as recreation, fish and wildlife, flood control and/or other purposes.

Water bodies such as San Luis, Russell and Mishak Lakes are situated in the closed basin at comparatively low elevations. They are recognized more for wildlife values than for irrigation, flood control, etc.

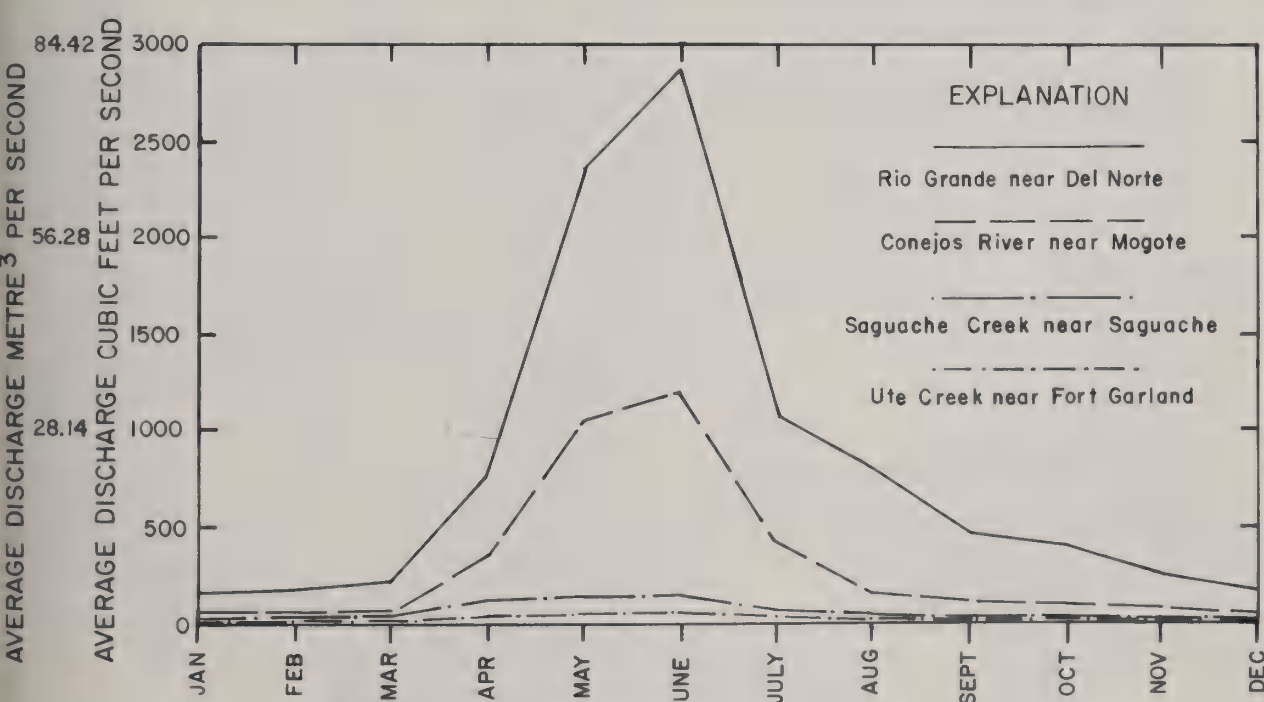
TABLE IV-4, SELECTED STREAMFLOW CHARACTERISTICS

Rio Grande Basin, Colorado

Stream and Gaging Station	Drainage Area (Sq. Miles)	(km^2)	Years of Record	Average Discharge for Period of Record to 1969: Cubic ft. Per Second	(m^3/s)	Acre Ft. Per Year	(Million m^3/yr)	Extremes of Discharge (Cubic Feet Per Second): Maximum	(m^3/s)	Minimum Daily	
Rio Grande at Thirty mile bridge near Creede	163	422	56.	215.	6.1	155,800	193	7,000	197.0	0.1	0.003
North Creek Below Continental Reservoir	51.7	134	40.	30.8	0.9	22,310	20	362	10.2	0	0
South Fork Rio Grande at South Fork	216	559	45.	211.	5.9	152,900	189	8,000	225.1	14.	0.394
Rio Grande near Del Norte	1,320.	3,419	80.	909.	25.6	658,600	812	18,000	506.5	69.	1.941
Rio Grande near Monte Vista	1,590.	4,118	43.	322.	9.1	233,300	288	18,500	520.5	1.5	0.042
Rio Grande at Alamosa	1,710	4,429	57.	254.	7.1	184,000	227	14,000	393.9	1.	0.028
Sagauche Creek near Saguache	595	1,541	57.	70	2.0	50,720	63	790	22.2	8.2 1/	0.231
Alamosa Creek Above Terrace Reservoir	107	277	43.	115	3.2	83,320	103	5,200	146.3	--	--
Ute Creek near Fort Garland	32	83	46.	20.6	0.6	14,920	18	630 2/	17.7	0	0
Conejos River near Mogote	282	730	60.	339.6	9.6	245,600	303	9,000	253.2	10.	0.281
Los Pinos River near Critz	167	433	50.	123	3.5	89,110	110	3,160	88.9	4. 3/	0.113
Conejos River near La Sauses	887	2,297	48.	187	5.3	135,500	167	3,890	109.5	0.	0
Culebra Creek at San Luis	220	570	42.	48.7	1.4	35 280	44	654	18.4	4.6	0.129
Rio Grande near Labatos	7,700	19,943	70.	603	17.0	436,900 4/	539	13.200	371.4	0	0

SOURCE: Surface water records of Colorado - 1969
1-Minimum daily recorded
2-Maximum daily
3-Minimum observed
4-Base period 1924-69 Flow = 328,800 ac. ft. (405,574,800 m^3)

Terrace Reservoir



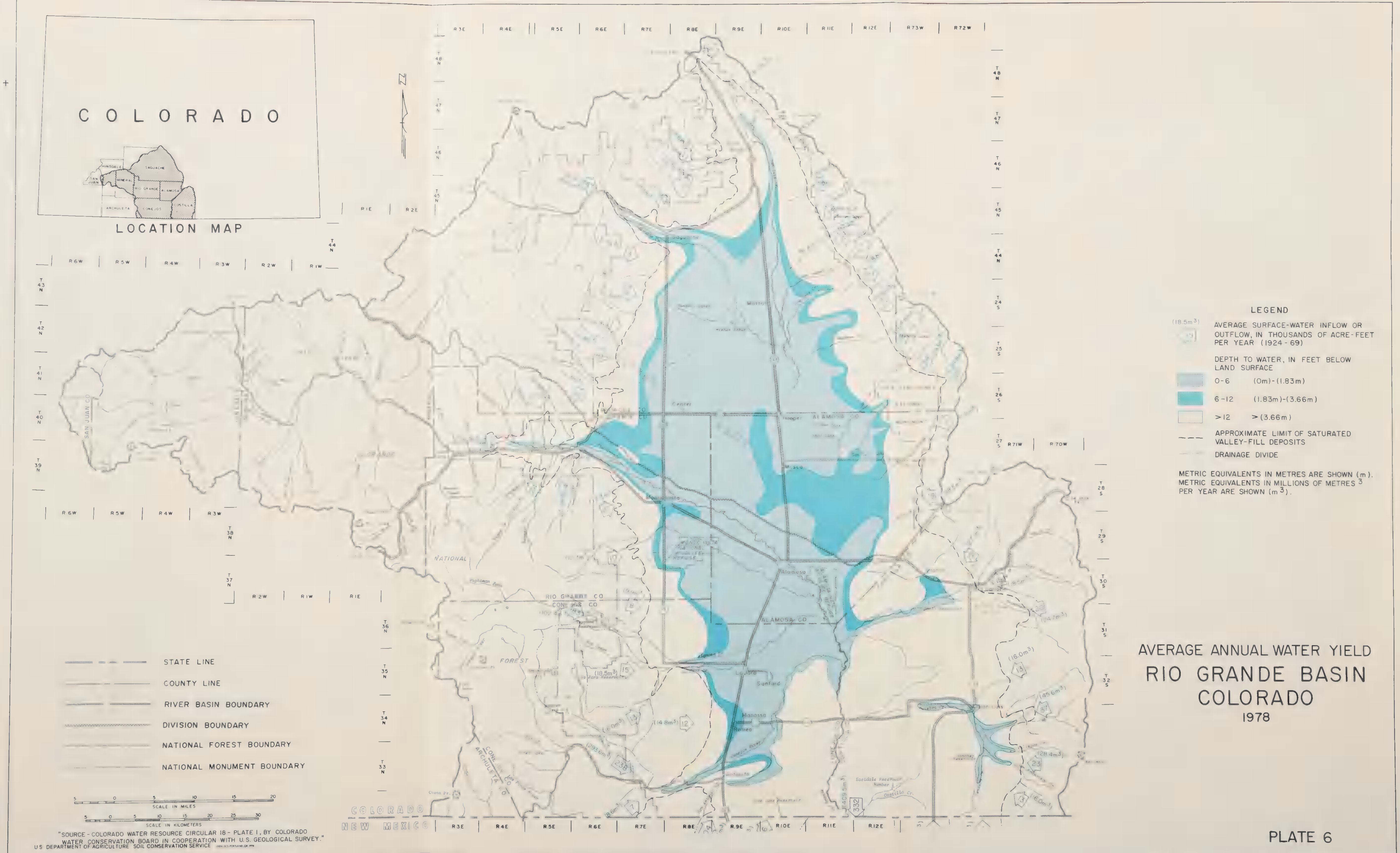
AVERAGE MONTHLY SURFACE-WATER INFLOW, 1924-69
RIO GRANDE BASIN, COLORADO

FIGURE IV-7

TABLE IV-5 Reservoirs
Rio Grande Basin, Colorado

NAME	CAPACITY IN ACRE FEET	(m3)
Rio Grande	51,110	63,044,185
Santa Maria	43,570	53,743,595
Continental	26,720	32,959,120
Beaver Park (San Luis) 1/	4,430	5,464,405
Archuleta	110	135,685
Spruce No. 1 1/	50	61,675
Spruce No. 2 1/	110	135,685
Fuchs	210	259,035
Troutvale No. 1 1/	510	629,085
Troutvale No. 2 1/	200	246,700
Sqaw	160	197,360
Poage	190	234,365
Road Canon 1/	2,800	3,453,800
Shaw	490	555,075
Bristol Head No. 1	150	185,025
Bristol Head No. 2	800	986,800
Regan Lake	520	641,420
Lost Lakes	970	1,196,495
Trout Lake	200	246,700
Goose Lake 1/	230	283,705
Spring Creek (Wrights) 1/	150	185,025
Meadow Lake 1/	120	148,020
Metroz	190	234,365
S U Dude	120	148,020
Hermit No. 1 1/	360	444,060
Hermit No. 2 1/	360	444,060
Ruby	120	148,020
Lake Cliff	20	24,670
Bergeys	30	37,005
Humphreys 1/	840	1,036,140
Platoro	67,800	83,631,300
Wee Ruby	190	234,365
Lake Cliff	20	24,670
Hunters Lake 1/	50	61,675
Terrace	17,700	21,832,950
La Jara	14,050	17,330,675
Cove Lake	9,710	11,977,285
Sanchez	103,160	127,247,860
Eastdale No. 1 & No. 2	3,470	4,280,245
Salazar	120	148,020
Mountain Home	19,150	23,621,525
Smith	5,340	6,586,890
TOTALS	376,960	464,980,160

1/ Recreation Reservoirs.



AVERAGE ANNUAL WATER YIELD
RIO GRANDE BASIN
COLORADO
1978

PLATE 6

Water used by wildlife.

(3) Interbasin Diversions

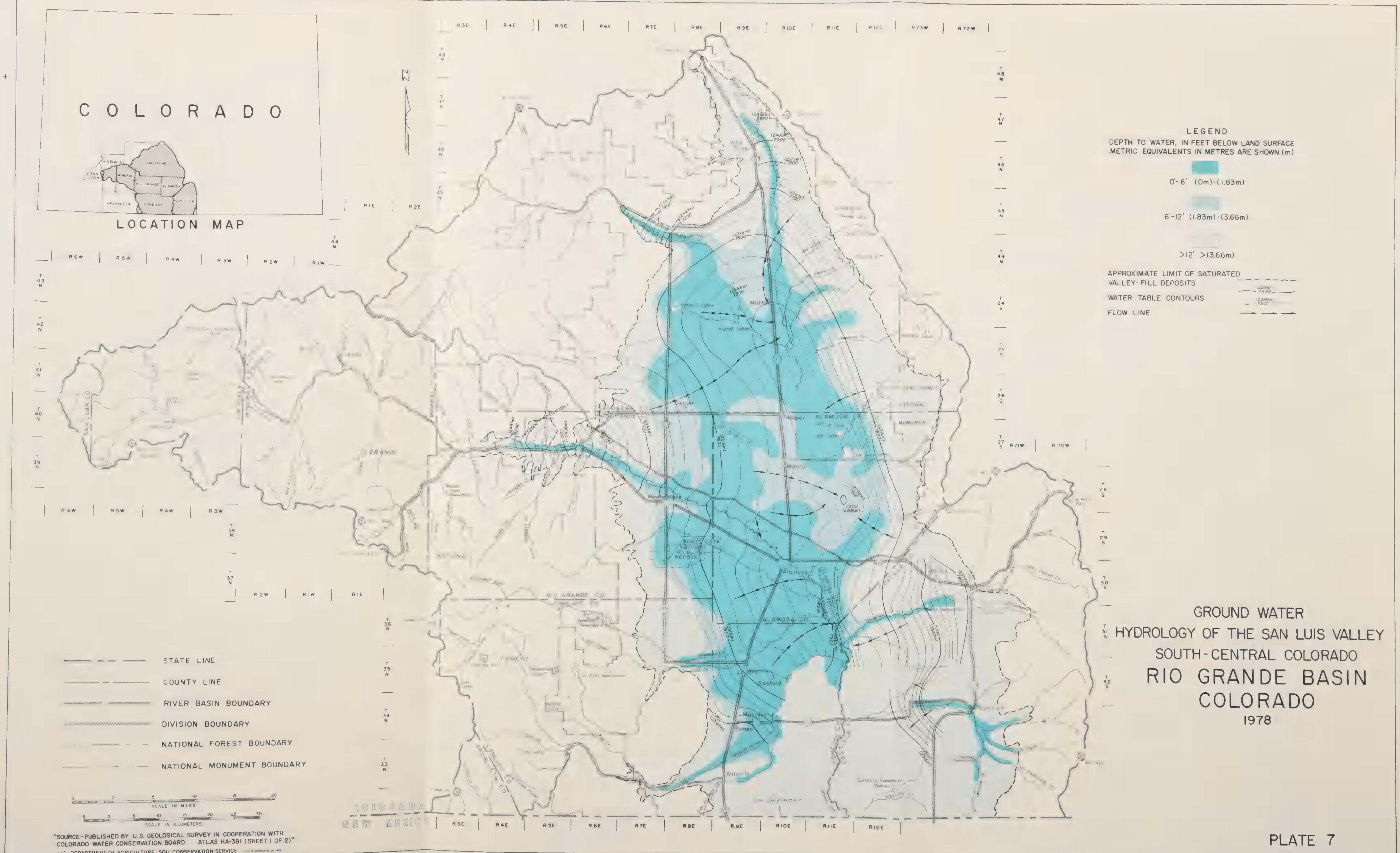
Interbasin diversions into the basin amount to 4,000 acre-feet (4,934,000 m^3) annually, a relatively small volume in relation to the total water supply. Seven ditches bring water into the Rio Grande from the Gunnison and San Juan River Basins. There are six which bring 89 percent of the imported water into sub-basin No. 4 and one that brings 11 percent into sub basin No. 7. The only significant water exported from the basin is by natural outflow at the Colorado-New Mexico state line.

b. Ground Water

Estimates show up to 2 billion acre-feet (2,467 billion m^3) of ground water are contained in the strata to a depth of 6,000 feet (1,829 m^3) below the basin floor. (See Plate 7). Much of this volume is considered to be located in two major aquifers--a confined system existing below clay barriers and an unconfined one above these barriers (See Figure IV-8). Approximately 80 percent of all large capacity irrigation wells withdraw water from only the unconfined aquifer. The remaining wells withdraw water from both systems. Evidence indicates that substantial upward leakage occurs from the confined aquifer to the unconfined through clay layers and from wells that penetrate both.

The ground water system in the basin functions similar to surface reservoirs. The unconfined aquifer follows the pattern of rising in the spring and early summer due to recharge from streams, canals and excess irrigation water, followed by a decline as streamflow decreases and pumping increases. Pumping records for a period of 10 years prior to 1970 showed an average annual withdrawal of 411,000 acre feet (507 million m^3) for irrigation.

Irrigation well pumping into unlined ditch


COLORADO
LOCATION MAP
LEGEND
DEPTH TO WATER, IN FEET BELOW LAND SURFACE
METRIC EQUIVALENTS IN METRES ARE SHOWN (m)
0'-6' (0m)-(1.83m)
6'-12' (1.83m)-(3.66m)
>12' >(3.66m)
APPROXIMATE LIMIT OF SATURATED VALLEY-FILL DEPOSITS
WATER TABLE CONTOURS
FLOW LINE
STATE LINE
COUNTY LINE
RIVER BASIN BOUNDARY
DIVISION BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL MONUMENT BOUNDARY
SCALE IN MILES
SCALE IN KILOMETERS
GROUND WATER
HYDROLOGY OF THE SAN LUIS VALLEY
SOUTH-CENTRAL COLORADO
RIO GRANDE BASIN
COLORADO
1978
PLATE 7
"SOURCE-PUBLISHED BY U.S. GEOLOGICAL SURVEY IN COOPERATION WITH COLORADO WATER CONSERVATION BOARD. ATLAS HA-381 (SHEET 1 OF 2)"
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE
Saguache
Moffat
Center
Hooper
ALAMOSA CO.
Mosca
Monte Vista
MONTE VISTA NATIONAL WILDLIFE REFUGE
Alamosa
RIO GRANDE CO.
CONEJOS CO.
La Jara
Sanford
Manassa
Romeo
Antonito
San Luis
COLORADO
NEW MEXICO

c. Water Quality

The chemical quality of stream water is generally excellent. Exceptions are the Kerber, Willow, and Alamosa Creeks. They are affected by mine drainage. Specific-conductance measurements made on 32 representative streams indicate the dissolved-solids concentration to be from 25 to 450 milligrams per liter. Water is a calcium bicarbonate type in streams unaffected by mine drainage and calcium sulfate in streams affected by mining. Specific-conductance values exceeded 500 microhomes in only 4 of the 32 sampled streams. Table D-1 of the Appendices lists specific-conductance values.

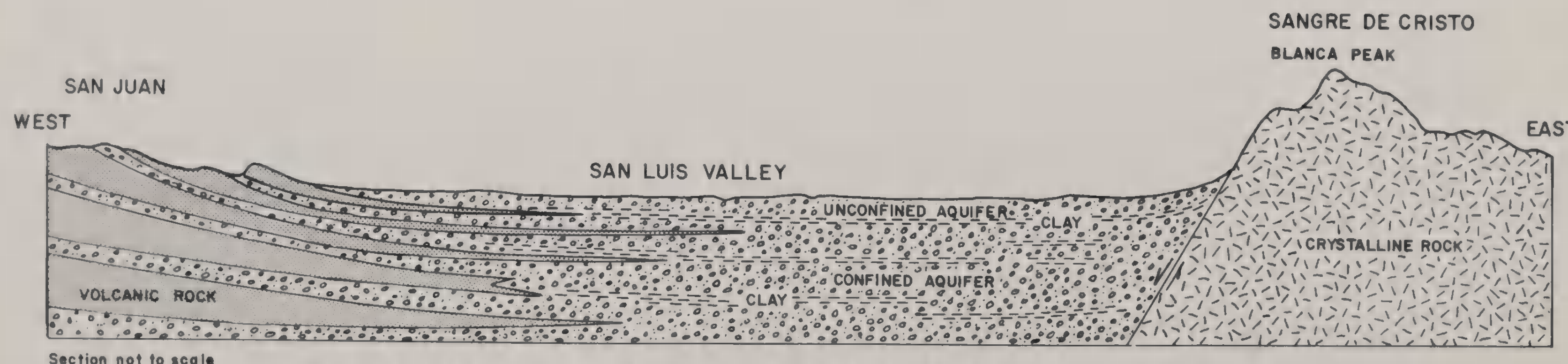
Chemical quality of the Rio Grande itself is influenced by diversions, return flows, and tributary and ground water inflows. Above Del Norte its water quality is controlled principally by natural effects. Below Del Norte, its quality is dependent upon effects from uses for agriculture, industry, and municipalities acting collectively to increase the proportion of dissolved solids. Appendix D presents a detailed discussion of the cause/effect of water quality relationship.

The chemical quality of ground water in the unconfined aquifer is the result of many complex and interrelated factors. They include the chemical quality of recharge water, mineralogy of the soils and sediments through which the water moves, and the concentrating effect of evapotranspiration. Quality is excellent around the rim of the basin, being a calcium bicarbonate type. However, as the water flows toward the center of the basin, a deterioration in quality occurs. Continued dissolution of soluble minerals from the soils and sediments as the water is recirculated through the irrigation cycle causes the dissolved-solids concentration to increase. In areas where the depth to water is less than 12 feet (3.7 m), evapotranspiration removes virtually distilled water from the unconfined aquifer causing a further increase of dissolved solids in the residual water.

The quality of the water in the confined aquifer is also excellent near the edge of the basin. The water moves downgradient where clay beds, lava flows and minerals exert their influence both chemically and physically. The general composition of the water as it moves toward the center of the basin becomes a sodium bicarbonate type. Medium- and high-sodium water exists in a much larger area in the confined aquifer system than in the unconfined. High-sodium water underlies some arable land, and is utilized for irrigation. When used on clayey soils there is danger of reducing their permeability.

GROUND WATER

RIO GRANDE BASIN, COLORADO



BLOCK DIAGRAM AND GENERALIZED GEOHYDROLOGIC SECTION

FIGURE IV-8

Water Quality - Dissolved Solids from Mill Tailings

In the central part of the closed basin, between the depths of 100 and 1,000 feet 30.5 and 304.8 m), the water of the confined aquifer has a brownish color and contains a flammable, hydrogen sulfide gas. Although the color in the water is generally considered harmless, it is commonly associated with high flouride concentrations, high to very high salinity, medium to high alkalinity, and various gases.

Underground fossil peat beds are believed to account for the organic derivatives that impart the brown color. Flouride concentrations range from 0.1 to 13 milligrams per liter in water from the confined acquifer. Since the recommended amount of flouride in drinking water is about 1.3 mg/l, it is apparent that this limit is exceeded in a large area of the basin. Flouride concentration increases with depth and distance from the basin periphery, with water from depths of 800 feet (243.8 m) or more generally containing higher amounts of flouride than water from shallower depths.

d. Water Rights and Compacts

(1) Intrastate

The Colorado Doctrine of Prior Appropriation was adopted in the very early irrigation days. The Doctrine, as set forth in the State Constitution, adopted in 1876, and judicial decisions state that: (1) water in its natural course is the property of the public and is not subject to private ownership; (2) a vested right to use the water may be acquired by appropriation and application to beneficial use; (3) the person first in time to use the water is first in right; and (4) beneficial use is the basis, the measure and the limit of the right.

An appropriation is accomplished by the application of water to a beneficial use. An important condition of the rule is that the initiation of the appropriation must be followed by the diligent construction of necessary works and the application of the water to beneficial use. If due diligence is proven, the date of priority reverts back to the initiation of the work, usually the date of the initial survey.

The Colorado Constitution also sets up an order of preferential use as (1) domestic, (2) irrigation, and (3) industrial. This preference for certain uses must not be confused with priorities. A preferred use does not automatically obtain a senior priority. The only practical effect of the preference is to give a preferred use the right to condemn a subordinate use. As an example, on occasions municipalities have obtained water rights covered by irrigation priorities through the use of the power of eminent domain.

The Colorado General Assembly enacted legislation in 1969 which changes the procedure for determination, changes in

and transfers of water rights, and provides for plans for augmentation. It is not applicable to designated ground water basins nor to wells solely for stock watering, domestic or other purposes, not exceeding 50 gallons per minute (3.2 L/S) of flow.

Water may be stored either in channel or off-channel reservoirs for future beneficial use. Water storage must be followed by beneficial use, which includes impoundment for recreational purposes, fishery and wildlife. The quantity of water to be stored must be defined, and in the case of off-channel reservoirs, the capacity of the inlet works described in the same manner as for direct diversion canals.

Responsibility for water administration and control in Colorado is divided between the state engineer, who is the executive officer of the Division of Water Resources of the State Department of Natural Resources, and the judiciary, specifically one district court judge, designated a water judge, for each of the seven water divisions of the state. The state engineer has exclusive jurisdiction to administer, distribute, and regulate the waters of the state. The water judges, on the other hand, have exclusive jurisdiction over water matters in the state district courts within their respective divisions. Water matters are those matters which are specified by statute to be heard by water judges. They include determinations of amounts and priorities on applications for new water rights and conditional water rights, and determinations of rights with respect to proposed changes of water rights, plans for augmentation, and biennial findings of diligence in the perfection of conditional rights.

Underground waters for many years have been used in Colorado without being properly incorporated into the priority system. Much effort was made by the General Assembly with the help of engineers and attorneys during the 1969 session to remedy the situation. General policies relating to integration of tributary ground water into the priority system are contained in the introduction.

In determining and administering the use of water, judicial and administrative officers shall be governed by the following: (a) If an appropriator uses a well, he may charge that diversion to his own appropriation or, if he also has a surface right taking from the same stream

system, he may, by using the proper procedure, have the well as an alternate point of diversion for his surface decree; (b) the widest possible discretion to permit the use of wells shall prevail. Lowering of the water table will be allowed if it later can be recharged so as to prevent injury to senior appropriators; and (c) as in other parts of the new legislation, provision is made for the interim period until procedures and paper work can be finalized.

One area of the state where considerable quantities of ground water can be found which do not contribute to adjudicated surface rights is the closed basin of the Rio Grande. Wells in this area compete with each other as surely as do ditches from surface streams.

The law provides for a ground water commission which has the authority to establish designated ground water basins. After designating a ground water basin, the commission, through the state engineer, issues permits for the use of ground water and establishes a priority date and number for each well in accordance with the doctrine of prior appropriation. The ground water commission is given rather broad powers to conserve the ground water resources of the designated basins and to protect vested rights of other appropriators. The state engineer is the enforcing officer for the commission.

(2) Interstate and International

Rio Grande Compact alludes to interstate and international implications which are applicable to the Rio Grande Basin in Colorado.

In 1906, the United States entered into a treaty with the Republic of Mexico by which the United States granted 60,000 acre-feet (74,010,000 m^3) of water annually to Mexico from the Rio Grande. The stated purpose of this treaty was to remove causes of international controversy on the waters of the Rio Grande arising above Fort Quitman, Texas. By a later treaty of 1944, the United States conceded additional rights from the Rio Grande to the Republic of Mexico from that portion of the river below Fort Quitman.

While the Treaty of 1906 became a national obligation, the burden of delivery fell upon the states of Colorado, New Mexico and Texas, and particularly upon the state of Colorado. Delivery to Mexico is made from the river

above El Paso, at which point most of the river flow originates from the state of Colorado.

In 1929, a temporary compact governing the use of Rio Grande waters was concluded among the states of Colorado, New Mexico and Texas.

In 1938, the compact commissioners of these three states signed the Rio Grande Compact, which was ratified in 1939, and is now in effect. The purpose of this compact was to allocate waters among the three states, which, for the most part, originate in Colorado. The compact was based upon two faulty premises: the precompact recorded flow of the river would repeat itself; and that diversions of water were all that was required to sustain the existing agricultural economy. Problems with the compact began to surface within a few years.

In 1952, the State of Texas initiated a suit against New Mexico in the United States Supreme Court in which it was alleged that New Mexico was not living up to its compact agreement. The United States intervened as an indispensable party but withheld its consent to be sued and the suit was dismissed. Subsequently, New Mexico improved its delivery capability through extensive channel rectification on the lower Rio Grande.

The states of Texas and New Mexico instituted proceedings against the state of Colorado in 1966 alleging that Colorado was in violation of the terms of the Rio Grande Compact. In 1967, the three states and the United States agreed to a stay of proceedings in the pending litigation to "afford a reasonable time for the interested parties demonstrate the imminence of an equitable administrative solution." On April 17, 1968, the attorneys general of Colorado, Texas and New Mexico signed a Motion for Continuance and Memorandum and mailed it to the United States Supreme Court. This continuance of the suit is based on the condition that "The State of Colorado undertakes to delivery water at the Colorado-New Mexico state line to meet every year the delivery obligation established by the schedules of Article III of the Rio Grande Compact. To this end the state of Colorado shall exercise its best efforts and use all available administrative and legal powers including, if necessary, the curtailment of diversions enforced by agents of the State."

(3) Federal Reserved Right

The question of the federal reserved water right and the nature of that right is currently in litigation in Colorado.

7. Atmospheric Conditions

Air quality studies in the Rio Grande Basin, conducted by the Colorado Air Pollution Control Division, suggest pollution of some consequence exists in the basin.

The particulate and sulphur oxide emissions from point sources have been inspected and sources in excess of 20 percent opacity have been cited. In terms of particulate emissions, stationary sources of fuel combustion accounted for nine percent of the total emissions. The majority sources were located in Alamosa County. Process loss amounted to 28 percent of the total emissions. Most emissions were created from local area sources, but approximately one-third resulted from mineral processing in Conejos County. Solid waste disposal incineration from area sources amounted to 51 percent of the total particulate emissions.

Smoke from sawmill waste burners is another source of air quality degradation. Emissions from transportation amount to seven percent of the total particulate emissions of which approximately one-third was produced by aircraft and two-thirds by railroads. Agricultural burning and forest fires accounted for five percent of the particulate emissions.

Forty-nine percent of the total sulphur oxide emissions were attributed to bituminous coal power plants in Alamosa County. Fifty-one percent of the emissions were attributed to railroads in Alamosa and Mineral Counties.

In addition to sources of air pollution cited by the Air Pollution Control Division, it is also believed that fugitive dust caused by strong winds greatly contributes to air pollution. Additionally, offensive odors have been noted to emit from some industrial operations. Although wind currents disperse air pollution, inversions or stagnant air conditions occur frequently during the winter, greatly magnifying pollution during these periods.

Although additional research into air pollution must be conducted, it is evident that the basin is currently producing more air pollution than is desirable, and in some areas, than is acceptable under the Air Quality Control Regulations.

B. Correlation of Resources to Objectives

In Chapter III the locally perceived problems were correlated to the national objectives of National Economic Development (NED) and Environmental Quality (EQ). These objectives were

further disected into the two components of the desired output of goods and services, and necessary resource management to achieve these goods and services. The purpose of this section is to correlate to each objective those resources available for alleviating the problems. Where more than one objective is related to the same resource segment, they are treated simultaneously for simplicity.

Some of the objectives can not be directly related to a specific natural physical resource. Legal, political and social forces may require redirection in order to combat a problem. The intent herein is not to attempt any form of redirection, but to point out those problem areas which are beyond the realm of this study, why they are, and within which sector the emphasis for redirection lies.

Objective and problem numbers in Table IV-6 below are congruent with those in Chapter III.

TABLE IV -6

CORRELATION OF NATIONAL OBJECTIVES, PROBLEMS AND RESOURCES

Rio Grande Basin, Colorado

<table>
<tr><th>NATIONAL OBJECTIVE</th><th>PROBLEMS</th><th>RESOURCES</th></tr>
<tr><td>NED 1</td><td>Inadequate water for late season irrigation.</td><td>Irrigation Water Resources
<table>
<tr><th>Month</th><th>Surface Water 1/ Acre Feet</th><th>(Million m3)</th><th>Acre Feet* Per Acre</th><th>m3/ha</th></tr>
<tr><td>April</td><td>104,350</td><td>128.7</td><td>0.171</td><td>521.7</td></tr>
<tr><td>May</td><td>366,050</td><td>451.5</td><td>0.600</td><td>1830.1</td></tr>
<tr><td>June</td><td>386,400</td><td>476.6</td><td>0.634</td><td>1931.9</td></tr>
<tr><td>July</td><td>197,100</td><td>243.1</td><td>0.323</td><td>985.4</td></tr>
<tr><td>August</td><td>126,300</td><td>155.8</td><td>0.207</td><td>631.5</td></tr>
<tr><td>September</td><td>81,000</td><td>99.9</td><td>0.133</td><td>404.9</td></tr>
<tr><td>Season</td><td>1,261,200</td><td>1,555.7</td><td>2.068</td><td>6305.5</td></tr>
<tr><td>Nonseason</td><td>174,800</td><td>215.6</td><td></td><td></td></tr>
</table>
*Irrigated acres 609,600 (246,705 ha)
1/ At point of diversion</td></tr>
<tr><td>NED 2</td><td>Over appropriation of streamflow; Withdrawals for Rio Grande Compact.</td><td>Socio-political structures at the state and local levels are the means for revising present statutes, and scrutinizing current concepts and attitudes for water allocation so as to eliminate overappropriation and fulfilling legal requirements of the Compact.</td></tr>
<tr><td>NED 3</td><td>Inefficient irrigation and delivery system.</td><td>Irrigated Land and Water Delivery
<table>
<tr><th>Irrigation System</th><th>Acres</th><th>Hectares</th></tr>
<tr><td>Surface</td><td>582,090</td><td>235,572</td></tr>
<tr><td>Sprinkler</td><td>27,500</td><td>11,129</td></tr>
<tr><td>Total Irrigated Land</td><td>609,590</td><td>246,701</td></tr>
</table></td></tr>
<tr><td>NED 4</td><td>Inadequate drainage.</td><td>Agricultural Drainage Lands
<table>
<tr><th></th><th>(Acres)</th><th>(Hectares)</th></tr>
<tr><td>With Drainage System</td><td>167,194</td><td>67,663</td></tr>
<tr><td>Without Drainage System</td><td>47,846</td><td>19,363</td></tr>
<tr><td>Total</td><td>215,040</td><td>87,026</td></tr>
</table></td></tr>
<tr><td>NED 5</td><td>Flooding</td><td>Lands subject to flooding 328,600 acres, (132,984 ha).
Communities subject to flooding 14.</td></tr>
<tr><td>NED 6</td><td>Low inherent fertility and organic matter.</td><td>Lands continuously denuded of vegetation without leaving residues or artificially applying humus and fertilizers will deteriorate in fertility and/or game matter. Socio-economic forces act on landowner attitudes regarding soil nutrient depletion.</td></tr>
<tr><td>NED 7
EQ 1</td><td>Wind Erosion.</td><td>Urban development subdivisions 3,336 acres, (1,350 ha).
Cropland subject to wind erosion -332,838 acres, (134,700 ha).
Potential windbreaks - total length - 330,480 feet, (133,745 ha).</td></tr>
<tr><td>NED [illegible]</td><td>Noxious weed control.</td><td>Weed control is primarily a problem to agricultural lands. They may be noxious for crop production but beneficial for ground cover and wildlife habitat. Control is dependent on landowner attitudes.</td></tr>
<tr><td>NED 9</td><td>Limited range of crops.</td><td>Suitable crop production in the basin is largely a function of physiography and climate. Until strains or varieties of crops are produced which are not presently adaptable to the basin, the number and types of crops will be limited to those currently produced.</td></tr>
</table>

TABLE IV-6
(Contd)
CORRELATION OF NATIONAL OBJECTIVES, PROBLEMS AND RESOURCES
Rio Grande Basin, Colorado

<table>
<tr><th>NATIONAL OBJECTIVE</th><th>PROBLEMS</th><th>RESOURCES</th></tr>
<tr><td>NED 10</td><td>Inadequate rural electrification</td><td>Psuedo-private industry responsible for providing rural electric energy is limited in its operational capability as to how rapid an area can be electrified</td></tr>
<tr><td>NED 11</td><td>Underdeveloped range resources and overgrazing.</td><td>
<table>
<tr><th>Range Resources</th><th>Acres</th><th>Hectares</th></tr>
<tr><td>Ownership/Administrator</td><td></td><td></td></tr>
<tr><td>U. S. Forest Service</td><td>981,570</td><td>397,241</td></tr>
<tr><td>Bureau of Land Management</td><td>495,991</td><td>200,728</td></tr>
<tr><td>U. S. Fish & Wildlife Service</td><td>23,342</td><td>9,447</td></tr>
<tr><td>State and Private</td><td>1,419,879</td><td>574,625</td></tr>
<tr><td>TOTAL</td><td>2,920,781</td><td>1,182,041</td></tr>
</table>
</td></tr>
<tr><td>NED 12</td><td>Inadequate sanitation.</td><td>Local government has already tackled this problem by developing plans for sewage and solid waste disposal.</td></tr>
<tr><td>NED 13</td><td>Inadequate municipal water supply.</td><td>The water supply to communities in the basin is from wells. Of 25 communities 16 have either no existing system or have a need to enlarge and improve existing systems. Vast amounts of high quality ground water exists in the basin, so there is ample opportunity for additional water to meet projected needs.</td></tr>
<tr><td>NED 14</td><td>Poor Housing</td><td>Resources to alleviate poor housing conditions consist of local government initiation of action for federal assistance through ongoing programs.</td></tr>
<tr><td>NED 15
EQ 2</td><td>Lack of recreational areas and facilities.</td><td>Developed Recreation Resources
<table>
<tr><th>Existing Developed Sites</th><th>Acres</th><th>Hectares</th><th>Inventoried Potential Sites</th><th>Acres</th><th>Hectares</th></tr>
<tr><td>Forest Svc</td><td>720 (a)</td><td>291</td><td>Forest Svc</td><td>5,455</td><td>2,208</td></tr>
<tr><td>Bureau of Land Mgmt.</td><td>0</td><td>0</td><td>Bureau of Land Mgmt.</td><td>40</td><td>16</td></tr>
<tr><td>State</td><td>834</td><td>338</td><td>State</td><td>0</td><td>0</td></tr>
<tr><td>Private</td><td>243</td><td>98</td><td>Private</td><td>200</td><td>81</td></tr>
<tr><td>Total Existing</td><td>1,797</td><td>727</td><td>Total Potential</td><td>5,695</td><td>2,305</td></tr>
<tr><td>National Park</td><td>36,816 (b)</td><td>15,626</td><td></td><td></td><td></td></tr>
</table>
(a) Includes ski area
(b) Includes total NP area</td></tr>
<tr><td>NED 16
EQ 7</td><td>Inadequate access to public land for recreation, hunting and fishing.</td><td>Many societal institutions must interact through their social-legal systems to develop rational means of obtaining right-of-way when access to these lands is not provided by conjunctive land management activities.</td></tr>
<tr><td>NED 17</td><td>Insufficient timber supply to operate existing mills at capacity; current level of timber management will not allow basin's resources to contribute their share of national future needs; significant mortality in over mature and significant stagnation in immature timber stands.</td><td>
<table>
<tr><th>Commercial Timber Resources</th><th>Acres</th><th>Hectares</th></tr>
<tr><td>Forest Service:</td><td>197,614</td><td>79,974</td></tr>
<tr><td>Roadless Areas</td><td>603,128</td><td>244,086</td></tr>
<tr><td>Multiple-Use</td><td>5,455</td><td>2,208</td></tr>
<tr><td>Potential Rec. Sites</td><td>20,009</td><td>8,098</td></tr>
<tr><td>Bureau of Land Management</td><td>164,000</td><td>66,371</td></tr>
<tr><td>Private</td><td>47,732</td><td>19,317</td></tr>
<tr><td>State & Private Mixed</td><td></td><td></td></tr>
<tr><td>Totals:</td><td></td><td></td></tr>
<tr><td>w/Roadless Areas</td><td>1,037,938</td><td>420,054</td></tr>
<tr><td>w/o Roadless Areas</td><td>840,324</td><td>340,079</td></tr>
</table>
</td></tr>
</table>

TABLE IV-6

CORRELATION OF NATIONAL OBJECTIVES, PROBLEMS AND RESOURCES
Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEMS	RESOURCES
NED 18	Fluctuating utilization of recreation resources.	Society itself must adjust its attitudes, customs and mores to dampen extremes in periodic utilization of recreation resources.
EQ 3	Water pollution from mine drainage and agricultural runoff.	Mine Pollution Number of streams affected ---- 12 Miles of streams affected ---- 69 111 km Agricultural Pollution Area of land subject to runoff - 243,000 acres 98,342 ha
EQ 4	Opportunities for scientific investigation and recreation in a wilderness setting may be significantly diminished.	Wilderness Resources Acres Existing Wilderness Areas 149,609 60,547 ha Inventoried Roadless Areas 463,920 187,748 ha
EQ 5 EQ 6	Decreasing big game winter range and migration routes threatened by urban development.	Effective Deer/Elk Winter Range Resources: Owner/Administrator — Acres — Hectares Forest Service 200,000 80,940 Bureau of Land Management 317,560 128,517 Private 76,800 31,081 State & Private Mixed 176,670 71,498 Total 771,030 312,036
EQ 8	Degradation of trout habitat due to siltation of streams by road construction and timber harvest activities.	Coldwater Fishery Resources Streams 1211 miles 1948 km Lake and Reservoirs 1800 acres 728 ha
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	Little is known of numbers or habitat requirements. Fish and wildlife on federal and state endangered and threatened lists: 1) Rio Grande cutthroat trout 2) peregrine falcon 3) black-footed ferret 4) greater sandhill cranes 5) whooping cranes 6) mexican duck 7) river otter 8) wolverine 9) lynx 10) grizzly bear 11) gray wolf
EQ 10	Smoke from sawmill burners degrades air quality.	Entire commercial forest resource may contribute to future log supply for forest products industry.

CHAPTER V

ECONOMIC PROJECTIONS AND ENVIRONMENTAL PREFERENCES

CHAPTER V - ECONOMIC PROJECTIONS AND ENVIRONMENTAL PREFERENCES

A. Historical Development

The Rio Grande Basin is the oldest settled and farmed area in Colorado. A hand-dug irrigation ditch was built in 1852 and is still in use today. In the early years small irrigated farms near the streams became prevalent in the lower basin, with sheep raising the predominant activity in the foothills and mountains. Large cattle ranches were established in the northern part of the basin.

Historic Town - Platoro, Colorado

A mining boom in the San Juan Mountains, beginning in 1870, provided jobs for many local residents and enticed many more people into the basin from other areas. This created markets for locally produced cattle, sheep and crops.

The Denver and Rio Grande Railroad completed a line to the present site of Alamosa, achieving a relatively inexpensive means of marketing basin products such as potatoes and wheat.

Crops are irrigated because the annual precipitation is less than 8 inches (0.20 m). The first major irrigation development was the Sylvia Ditch in 1866 which was developed to irrigate land in the basin proper. The largest canal (Rio Grande Canal) went into operation in 1881 and diverted water into the closed basin. By 1900, some 1,800 miles (2,896 km) of canals and ditches had been constructed. Developments since 1900 have been largely confined to improvements of existing systems and installation of many irrigation wells.

Commercial agriculture is still the most important basic industry in the basin, with large areas of vegetables, potatoes, hay lands and livestock. Cattle and sheep production has been and remains an important segment of the basin's economy.

The agricultural situation is sensitive to market conditions and outside competition, with a great deal of marginal land being abandoned and many farms being consolidated. Several inter-related economic factors contributed to this economic situation. Price levels, labor shortages, outside competition, increased capital investment, higher taxes, etc., are associated factors of the economic problems that farmers have experienced. The isolation of the basin creates further competitive disadvantages for producers. Further, the distance to populated markets is greater, adding to transportation costs which are already high, and weather conditions in the mountains can make transportation difficult during the winter months.

B. Socio-economic Indicators

1. Population Characteristics

The basin's population depicts the general trend occurring in rural areas of the United States--a declining situation. Population reached a high in 1940 and has declined since, with the exception of the last few years (See Table V-1). This trend is not applicable to all areas of the basin. For example, Alamosa County experienced a steady increase in population except for the 1950 decade. Still, the general trend for the basin's overall population for the past three decades has been one of decline.

Data in Table V-2 indicate approximately 45 percent of the basin's population to be of Spanish and 55 percent Anglo heritage. Conejos and Costilla counties have a majority of Spanish heritage population and the rest of the basin has an Anglo majority.

TABLE V-1

POPULATION TRENDS

Rio Grande Basin, Colorado

Year	Basin Total	Percent Change	State Total	Percent Change	Basin as a Portion of State (Percent)
1900	23,272		539,700		4.31
1910	28,745	23.52	799,024	48.05	3.60
1920	31,868	10.86	739,629	-7.43	4.31
1930	41,037	28.77	1,035,791	40.35	3.96
1940	49,217	19.93	1,123,296	8.45	4.38
1950	45,963	-7.04	1,325,089	17.70	3.47
1960	38,704	-15.79	1,753,947	32.36	2.21
1970	37,466	-3.20	2,207,259	25.84	1.70
1973*	43,188	15.30	2,510,394	13.73	1.72

* Colorado regional and county population estimates, 1970 to 1980, Summary Report, prepared for the Colorado Division of Planning by the Business Research Division, Graduate School of Business Administration, University of Colorado, Boulder, Colorado 80302, July 1974.

Source: 1900-1970 U. S. Census of Population

TABLE V-2

POPULATION AND SOCIAL CHARACTERISTICS 1/

Rio Grande Basin, Colorado

	Alamosa	Conejos	Costilla	Mineral	Rio Grande	Saguache	Basin Total
Total Population	11,422	7,846	3,091	970	10,494	3,827	37,650
Persons of Spanish Language	3,586	5,242	2,341	-	4,106	1,507	16,782
Other Persons of Spanish Surname	265	65	57	-	70	24	481
Persons of Spanish Origin or Descent	3,938	2,990	1,148	-	2,840	1,772	12,688
Born in State of Residence	7,488	6,667	2,438	596	6,609	2,531	26,329
All Workers	4,243	1,934	725	298	3,580	1,185	11,965
School Enrollment	4,582	2,932	1,210	323	3,320	1,192	13,559
Mother Tongue							
English	7,696	2,491	563	879	6,133	2,306	20,068
French	68	-	9	-	-	-	68
German	228	35	14	8	278	38	601
Spanish	2,957	4,956	2,329	-	3,694	1,397	15,333
Other	473	364	176	83	389	86	1,571

1/ Population in Hinsdale, Archuleta, and San Juan Counties is considered very minor.

Source: U. S. Department of Commerce, 1970 Census of Population.

Estimates of those migrating from the basin show that the highest percentages fall within the 10-24 age group (see Table V-3). This total would probably be higher except for the large numbers of students who come to the basin to attend Adams State College. The data also indicate a relatively large group of people over 60 years of age leaving the basin. This retirement age group probably is seeking warmer climates for their latter years.

The Rìo Grande Basin generally provides adequate educational opportunities on all levels with public elementary and secondary schools, a state college, and a vocational school. All of the 14 school districts are small, serving the needs of a predominantly rural population. The overall percentages shown of students graduating from high school are considerably below the state of Colorado's percentages (See Table V-4). The high drop-out rate of Spanish-Amercian students would indicate a need for innovative educational programs that could hold these students in school for a longer period of time.

Adams State College, situated in Alamosa, was established in 1921 as a State Normal College, and now offers a wide range of subjects leading to baccalaureate and master degrees. The college retains its historic role of preparing students for teaching careers with over 60 percent of its graduates pursuing this field, but a recent emphasis has been placed on the broader programs in other areas. This diversification should help meet the changing needs in higher education within the region.

2. Industry and Employment

Commercial agriculture is the most important basic industry. In terms of employment, however, wholesale and retail trade accounted for 21 percent; agriculture comes second with 19 percent, followed by government and services at 18 percent of the total employment. Only 5 percent of the employed labor force held manufacturing jobs in 1970, compared with 15 percent in the state of Colorado.

One of the most dynamic industries is the tourist industry. Improved facilities and transportation have helped the tourist industry to have steady growth and contribute substantially to retail sales as people have come to take advantage of a variety of natural and cultural attractions throughout the basin.

Retail trade, in response to the tourism and agriculture sectors, represents 58 percent of all sales and employs more than one out of every 5 persons.

TABLE V-3

POPULATION MIGRATION, 1969-70 (ESTIMATED)
Rio Grande Basin, Colorado

Age Group	MALE Avg. No. of Migrants Per Year	FEMALE Average. No. of Migrants Per Year
04	- 3	+ 26
5-9	- 2	- 21
10-14	-113	- 96
15-19	-137	-107
20-24	- 50	- 31
25-29	- 12	- 8
30-34	- 4	- 3
35-39	- 8	- 7
40-44	- 5	- 11
45-49	- 8	- 10
50-54	- 3	- 3
55-59	- 7	- . 8
60-64	- 12	- 10
65-69	- 13	- 10
70-74	- 8	- 9
75+	- 22	- 32
TOTAL	-406	-392
Cum. Total	-798 Persons	

Source: San Luis Valley Council of Governments

TABLE V-4

EDUCATION
Rio Grande Basin, Colorado 1/

	BASIN	
No School		
Spanish		
Other		
8th Grade or Less	6,075	
Spanish	4,158	(68.4%)
Other	1,971	(31.6%)
High School Graduation	9,178	
Spanish	1,803	(19.6%)
Other	7,375	(80.4%)
Some College	2,965	
Spanish	539	(18.2%)
Other	2,426	(81.8%)
College Graduation	1,926	
Spanish	261	(13.6%)
Other	1,665	(86.4%)
Median Education	N.A.	
Spanish	N.A.	
Other	N.A.	
%H. S. Graduates	50.4	
Spanish	24.6	
Other	70.9	

1/ There are no schools located in Hinsdale, Archuleta, and San Juan Counties, portion of the Rio Grande Basin.

Source: U. S. Bureau of the Census: 1970 Census of Population: General Social and Economic Characteristics, Colorado.

Resort Area on Conejos River

Approximately 34 percent of the basin's population 16 years of age and over was in the civilian labor force (see Table V-5). The percentage of the work force was six percent below the state of Colorado's 30 percent. Slightly less than half of the population 16 years or over is not in the labor force. Unemployment rates are also much higher for the basin's Spanish-surnamed population; some 9 percent of this segment of the labor force was unemployed. Spanish-surnamed males had a 11 percent rate of unemployment compared with 5 percent for the male population as a whole.

TABLE V-5

LABOR FORCE CLASSIFICATION OF POPULATION 16+BY SEX, AGE, AND ETHNICITY

Rio Grande Basin, Colorado

	Region 8 Total	Civilian Labor Force	Employed	Unemployed	Percent of L.F.	Persons Not in L.F.	Want Work Now	Intend to Look/Work	Do Not Want Work
Population	27,600	15,260	14,381	879	5.8	12,340	855	822	10,663
Sex and Age									
Males	12,984	9,117	8,704			3,867			3,346
16-21	2,112	1,272	1,100			840			511
22-29	2,264	1,903	1,754			361			262
30-44	2,734	2,551	2,528			183			156
45-64	3,679	3,011	2,942			686			647
65+	2,177	380	380			1,797			1,770
Females	14,616	6,143	5,677			8,473			7,317
16-21	2,280	985	696			1,295			669
22-29	2,448	1,571	1,525			877			721
30-44	3,138	1,853	1,723			1,285			1,148
45-64	4,167	1,611	1,611			2,556			2,373
65+	2,583	123	122			2,460			2,406
Age Group Totals									
16-21	4,392	2,257	1,796			2,135			1,180
22-29	4,711	3,474	3,279			1,237			982
30-44	5,872	4,404	4,251			1,468			1,304
45-64	7,864	4,622	4,553			3,242			3,020
65+	4,761	503	502			4,258			4,177
Ethnicity and Sex									
Anglo and Other	15,588	8,768	8,408			6,820			6,104
Male	7,148	5,209	5,050			1,939			1,691
Female	8,440	3,559	3,358			4,881			4,413
Spanish-American	12,012	6,492	5,973			5,520			4,559
Male	5,836	3,908	3,654			1,928			4,559
Female	6,176	2,584	2,319			3,522			

Source: San Luis Valley Labor Force Survey: October, 1976, SLVCOG

3, Income and Welfare

In analyzing the occupations and earnings in the Rio Grande Basin, there are many weaknesses evident related to the standard of living available to local residents as compared to the statewide standards of Colorado. In the basin, 23 percent of the jobs could be classified in the low pay and low status category as contrasted to only 14 percent for the state of Colorado.

Figures also show marked differences in the occupational employment of Spanish-surnamed residents compared with the basin population as a whole. Only 9.2 percent of the Spanish-surnamed held professional jobs, compared with 13.6 percent of the basin population. A much lower percentage of Spanish-surnamed were also shown for sales workers, clerical and kindred workers, and farmers and farm managers. Greater percentages of Spanish-surnamed were shown for occupational categories including operators, service workers, farm laborers and farm foremen. Indications are that Spanish-surnamed workers earned significantly lower incomes than other workers. Spanish-surnamed males earned approximately 28 percent less in professional occupations, 19 percent less as craftsmen, 20 percent less as operatives, 51 percent less as farmers and farm managers than the estimates show for the total basin population.

Lower earnings for the occupations within the basin are due to a number of factors, some of which are fewer weeks worked and more frequent periods of unemployment, and the overall weak influence of unions on area wages. Fewer males (48.5 percent) and females (15.8 percent) worked 50 to 51 weeks out of the year, compared to the state where 57.8 percent of the men and 22.0 percent of the women worked consistently year round.

Other indications of earning inadequacies are reflected in Census statistics on family income and families in poverty. The median income in 1969 of all families was $6,088 per year compared to $9,555 for the state of Colorado. Spanish-surnamed families showed median incomes of $4,401 which is nearly one-third less than the basin population as a whole and less than half of statewide median incomes.

The 1970 Census data indicates 24 percent of all families experienced poverty incomes. Forty percent of these were Spanish-surnamed families. The statewide percentage of poverty families was 12 percent.

The problem of poverty is one of the most critical social conditions present throughout most of the basin. One out of every five persons receives some form of public assistance. Table V-6 shows the greatest single expenditure is for old age pensions, although the number receiving aid in this category has decreased since 1960. Conversely, the second largest group of recipients, aid to dependent children, has been increasing during this time period.

The percentage of residents receiving public assistance has been increasing at a fast rate in recent years. This trend is somewhat misleading because of the inclusion of food stamp recipients. Food stamp assistance is a federal program and partially explains why the per capita welfare expenditures by county have gradually decreased while the number of recipients have steadily increased (see Table V-7).

Costilla and Conejos counties ranked first and second in Colorado in the percentage of residents receiving public assistance. Costilla County has one out of every two persons receiving public assistance, and Conejos County has one out of every three persons receiving assistance. Of the six counties, four are consistently ranked in the top ten counties in Colorado in the proportion of residents receiving public assistance.

Persons in the basin receiving welfare benefits in December 1975 made up 24 percent of the population, compared with 9 percent for the state of Colorado. The percentages ranged from 5 percent in Mineral County to 43 percent in Costilla County.

A contributing factor to the problem of inadequate earnings, poverty situations, and welfare dependence is the high cost of living. An inter-city index report by the American Chamber of Commerce Researchers' Association on cost of living study for ten Colorado cities for the fourth quarter of 1973 found Alamosa the third most expensive city in Colorado.

4. Transportation

The Rio Grande Basin, although somewhat isolated geographically, has a variety of transportation facilities serving the area. Because the population is sparse and widely distributed throughout the basin, the level and frequency of service is not extensive.

Two major U. S. highways serve the basin. Highway 285 enters over Poncha Pass in the north and continues southward to New Mexico. Highway 160 (Navajo Trail) is the major artery

TABLE V - 6

TYPES OF PUBLIC ASSISTANCE 1/

Rio Grande Basin, Colorado

	OLD AGE PENSION		AID TO DEPEND. CHILDREN			WORK INCENTIVE PROGRAM			AID TO THE NEEDY DISABLED		AID TO THE BLIND		GENERAL ASSISTANCE		FOOD STAMPS	SUPPL.	
June 1972	Cases	Avg. $	Cases	Children	Avg. $	Cases	Children	Avg. $	Cases	Avg. $	Cases	Avg. $	Cases	Avg. $	Recip.	FOOD	TOTAL
Alamosa	275	87.73	75	188	158.42	25	93	230.76	46	65.54	-	-	1	15.00	175	-	597
Conejos	452	98.42	105	375	140.57	19	50	191.94	102	67.31	-	-	-	-	283	316	1322
Costilla	298	103.94	70	172	137.12	1	1	125.00	37	65.94	3	62.33	-	-	180	262	851
Mineral	10	73.50	3	4	75.66	-	-	-	1	28.00	-	-	-	-	4	-	18
Rio Grande	317	79.58	152	431	166.24	20	51	176.05	72	60.76	-	-	2	44.00	209	303	1075
Saguache	170	85.51	77	212	150.97	9	14	148.22	37	62.24	-	-	1	30.00	73	-	367
Basin	1522	92.04	527	1382		74	209		295		3		4		924	881	4230
Sept. 1970																	
Alamosa	352	84.51	56	175	178.93	19	65	214.63	40	61.48	1	93.00	2	14.00	122	-	592
Conejos	599	95.54	119	344	156.08	21	56	214.86	78	61.03	-	-	2	22.50	254	260	1333
Costilla	387	102.10	63	133	116.06	1	2	56.00	39	55.41	2	72.50	1	68.00	198	226	917
Mineral	11	61.57	4	7	91.00	-	-	-	2	8.50	-	-	-	-	2	-	19
Rio Grande	403	82.40	100	292	166.60	17	56	210.18	45	55.16	-	-	-	-	204	272	1041
Saguache	230	84.56	80	234	147.48	10	22	163.80	31	59.19	-	-	-	-	76	-	427
Basin	1982	90.73	422	1185		68	201		235		3		5		856	758	4329
Sept. 1960																	
Alamosa	423	83.94	50	140	94.60	-	-	-	42	58.99	2	55.00	4	25.25	-	-	521
Conejos	646	93.42	97	310	105.57	-	-	-	66	53.73	2	37.00	4	46.62	-	-	815
Costilla	461	94.27	46	146	100.25	-	-	-	28	44.23	4	36.88	3	36.50	-	-	542
Mineral	39	69.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39
Rio Grande	535	89.14	111	375	108.59	-	-	-	35	63.94	1	97.00	7	34.14	-	-	689
Saguache	284	93.28	91	254	94.54	-	-	-	30	44.44	3	52.17	11	20.88	-	-	419
Basin	2388	90.53	395	1225					201		12		29				3025

1/ Public Assistance in Hinsdale, Archuleta, and San Juan Counties is considered very minor in this report.

Source: Colorado Dept. of Social Services, Div. of Public Welfare: Fiscal Report.

TABLE V- 7

PUBLIC ASSISTANCE EXPENDITURES 1/

Rio Grande Basin, Colorado

	1969-70			1965-66			1960	
	RECIPIENTS	EXPENDITURES DOLLARS	PER CAPITA	RECIPIENTS	EXPENDITURES DOLLARS	PER CAPITA	EXPENDITURES DOLLARS	PER CAPITA
Alamosa	999	582,200	51.93	685	664,900	63.32	620,100	62.01
Conejos	2,546	1,116,200	145.65	1,222	1,157,300	130.03	1,016,600	120.62
Costilla	1,529	626,500	217.61	970	762,800	200.74	678,600	160.85
Mineral	18	11,300	15.68	29	31,400	67.84	41,730	98.42
Rio Grande	1,507	743,100	72.32	1,009	949,200	79.76	888,200	79.59
Saguache	703	409,200	112.82	547	481,700	100.36	518,700	115.97

1/ Public Assistance in Hinsdale, Archuleta, and San Juan Counties is considered very minor in this report.

Source: Colorado Department of Social Services, Division of Public Welfare: Fiscal Report.

from La Veta Pass in the east to at Wolf Creek Pass in the west. There are also 19 state maintained highways.

Two bus lines, one major railroad (Denver and Rio Grande) and two short railroad lines serve the area. There is no railroad passenger service, however. Frontier Airlines plus four charter firms provide air transportation for the area.

C. Present Economic Conditions

Traditionally, livestock and crop production have been relatively close in their importance to agriculture. But in recent years, crop production and exports have become increasingly more significant in the agricultural sector. Hogs, poultry and dairy operations are of little regional importance.

1. Agricultural Production

Potatoes are the most important cultivated crop, surpassing the combined value of all other cultivated crops. Barley, hay, and vegetables rank second, third, and fourth respectively in dollar income. Barley has become more important with increased demand for the grain as a malting product (Table V-8). Crop production is confined mainly to those areas displayed in figures V-1, V-2, and V-3.

Irrigated Cropland - Potatoes

TABLE V-8

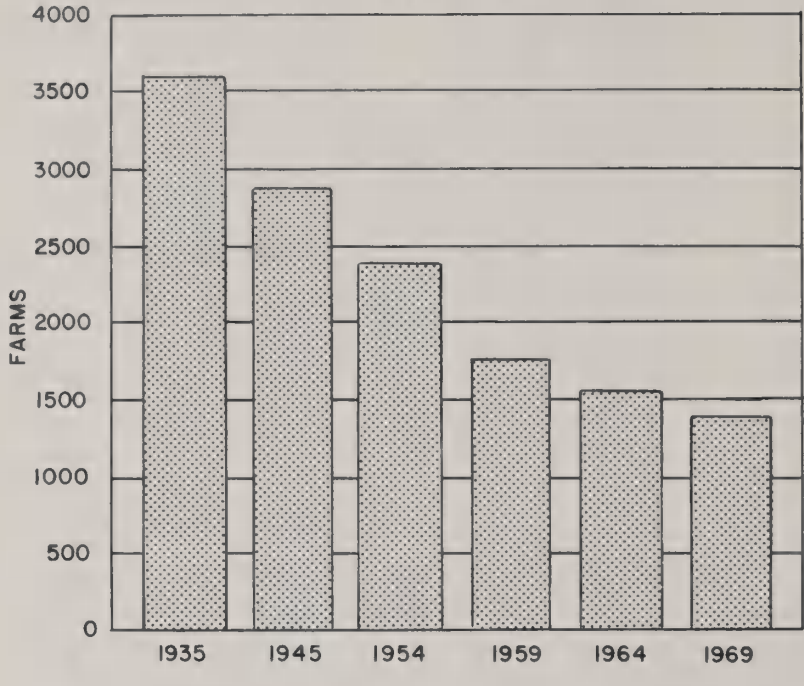
FARM CROP PRODUCTION - 1974 *

Rio Grande Basin, Colorado

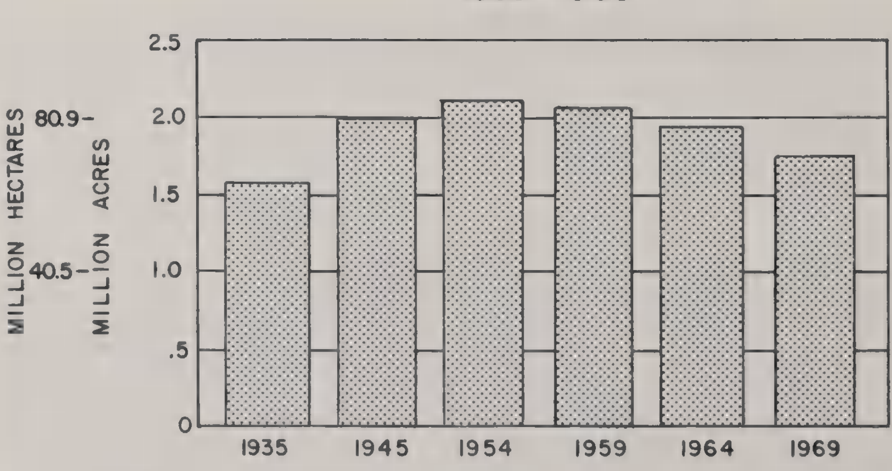
Crops	Acres	Hectares	Yield per Acre	Yields per Hectares	Total Value (Million Dollars)
Potatoes	35,000	14,165	250 Cwt.	4,590 kg	21.0
Barley	82,000	33,185	50 Bu.	0.73 m^3	14.7
Malt	75,000	30,353	50 Bu.	0.73 m^3	13.7
Feed	7,000	2,833	50 Bu.	0.73 m^3	1.0
Alfalfa Hay	109,000	44,112	1.7 Ton	0.61 +	9.25
Grass Hay	90,000	36,423	1.3 Ton	0.61 +	4.68
Oats	11,000	4,452	40 Bu.	0.57 m^3	1.1
Wheat	4,000	1,619	45 Bu.	0.65 m^3	0.810
Vegetables	4,000	1,619	Various		

*Source: San Luis Valley Extension Service (Handout), 1974.

NUMBER OF FARMS
1935 - 1969

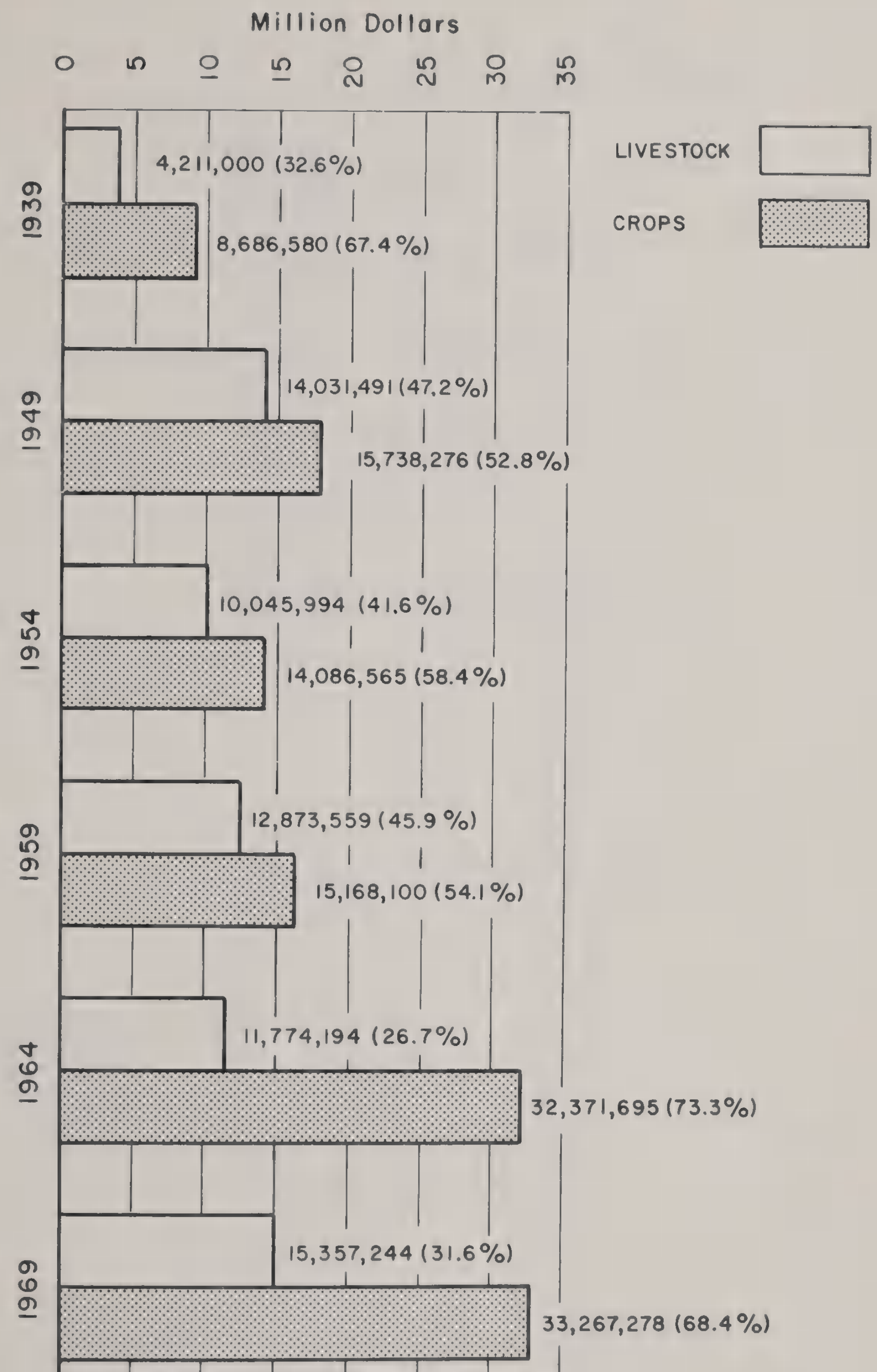


LAND IN FARMS
1935- 1969



Source: U.S. Department of Commerce, U.S. Bureau of Census, Census of Agriculture

FARM CHARACTERISTICS
RIO GRANDE BASIN, COLORADO
FIGURE V-1



VALUE OF LIVESTOCK AND CROPS (1939-1969)
RIO GRANDE BASIN

Source: U.S. Department of Commerce, U.S. Bureau of Census, Census of Agriculture

FIGURE V-2

Source: San Luis Valley Council of Governments Comprehensive Plan Vol. I

FIGURE V-3

USDA-SCS-PORTLAND, OR. 1978

In 1969, 40,000 acres (16,188 ha) of potatoes produced cash sales of almost $16,000,000, representing almost 47 percent of the total value received locally from all crops. The estimated 1974 value was $21,000,000. Potatoes are the only agricultural commodity in the basin other than barley with any form of promotion or marketing agreements. An administrative committee is appointed to promote and regulate potato production in Colorado, and an inspection committee is set up to oversee the quality standards or local production. Marketing agreements among local growers attempt to control the size, quality, and maturity of the crop.

Most growers are also shippers and the shipments are made primarily by truck because of inconvenient rail service. Shipments are occasionally made to points as far as Chicago or San Francisco, but more often to markets in Arizona, Louisiana and Texas.

A national trend in the potato industry is moving rapidly toward processed potatoes and away from fresh or baker potatoes. Currently, the production of potatoes is almost exclusively for the fresh market with only very minor secondary starch production from culled potatoes. The regions with good processing facilities have comparative advantages over regions which do not. With only starch and small quantities of flake production, the basin is in serious competitive trouble. In 1971 it was thought that a processing plant would locate in the basin, but construction was not started.

Barley has been increasing in importance. Most of the increased production has been malting barley grown under contract to breweries. About 90 percent of the barley produced has been for malting purposes, the other 10 percent grown for feed. Cereal grains (wheat, oats) are relatively unimportant in the basin.

Hay is the number one crop in acreage. Alfalfa represents about 63 percent of the hay grown and wild hay 37 percent according to 1974 estimates. Value of production follows a similar pattern.

Commercial vegetable production is concentrated in Costilla County. Spinach, cabbage and carrots are major products and they are exported throughout the nation by rail. Lettuce is becoming less significant because of competitive pressures from outside the basin. Adequate labor and migrant housing facilities have been the most pressing local problems related to production. In the past a greater variety of vegetables were grown, but labor, market and other problems have caused a great reduction in both acreage and variety.

Texas Longhorns - South Fork, Colorado

2. Livestock Production

Cattle are the most important livestock commodity, and are commonly found in combination with related hay and feed grain production on the same farm. Forest lands are increasing in importance for summer range. The future expansion of range cattle operations depends to a large degree upon the availability of these grazing lands. For example, during 1974, grazing on National Forest and Bureau of Land Management lands consumed some 64,000 and 34,000 animal unit months (AUMS) respectively. Assuming 35 percent of the total AUMS to be sheep, with a wholesale value of red meat produced at $58 per AUM, and the other 65 percent of the total AUMs to be cattle, with a comparable value of $26/AUM, the wholesale red meat value of sheep and cattle production approximates $1,989,000 and $1,656,000 respectively. (These figures are not the

market values of an AUM, but estimate the wholesale values of livestock sold by ranchers and feeders.) With a total annual value of $3,645,000 for red meat produced, the grazing industry on Federal lands plays a major role. The total inventory values (not sales) of all cattle and sheep as of January 1, 1969 and 1974 in the entire basin are noted in Table V-9 as 19 million and about 55 million dollars for cattle and calves and about 3.7 and 3.4 million dollars for sheep and lamb respectively.

Lamb production for meat is locally the most important use of sheep. A federal subsidy on wool is helping many operators and allowing them to continue production. Most livestock operations combine sheep and cattle, with flock sheep being the most popular locally. There is significant range grazing activity that takes place on forests during the summer and southward into New Mexico during the winter months.

Several problem areas in the local and national sheep industry serve to explain its rapid decline in importance. They are as follows: the industry is particularly short of capable and dependable herders and shearers; high costs for product processing; large losses of stock throughout the basin due to lack of predator control, particularly coyotes; and consistently low prices, competition from synthetics, and high import quotas tend to stagnate the wool market.

3. Forest-Related Products

Forest-related products are those outputs commonly associated with forest environs. Included here are timber, grazing, recreation and game wildlife and fish. Other forest-related values are not easily quantified, but have considerable social values. These would include esthetics, wildlife, and water quality and flow regulation.

Timber harvested in the Rio Grande Basin during 1974 amounted to some 29 million board feet on all ownerships, most all of it coming from national forest land. The average 1974 market value of the lumber of all species was $175 per thousand board feet, creating a total market value of over $5 million for lumber and wood products manufactured from the 1974 harvest.

495,000 visitor days occurred in the developed campgrounds on National Forest lands in 1974. Total expenditures (outlay) (Table V-10) amounted to nearly 6.0 million dollars for developed recreation (although not a true measure of value) indicating the importance of this activity in the basin.

TABLE V-9. Livestock Production
Rio Grande Basin, Colorado1/

	Cattle and Calves		Sheep and Lambs	
	1969	1974	1969	1974
County	---Number of head---			
Alamosa	18,000	17,500	23,500	12,000
Conejos	31,000	39,000	38,000	31,000
Costilla	7,400	10,000	15,600	6,500
Mineral	1,800	4,000	1,900	1,500
Rio Grande	22,800	28,500	43,000	21,000
Saguache	44,000	53,000	22,000	12,000
Basin total	125,000	152,000	144,000	84,000
Farm value	---$1,000---			
Basin total	19,000	54,720	3,744	3,402

1/ Livestock production in the Hinsdale, Archuleta and San Juan portion of the basin is very minor.

Source: Colorado Crop and Livestock Reporting Service Colorado Agricultural Statistics. Farm value derived using state average value per head.

TABLE V-10

RECREATION ON PUBLIC LANDS - 1972

Rio Grande Basin, Colorado

Agency	Total Visitor Days/Yr 1/ (1,000)	Participant Expenditures ($ per v.d.)	Total Outlay ($1,000)
Forest Service			
Campgrounds	495	7.00	3,465
Ski Area	96	20.25	1,944
Wilderness	59	5.60	330
State	10	7.00	70
National Park	79	7.00	553

1/ Based on agency estimates.

Wilderness areas are unique to national forest lands. In 1974, the La Garita Wilderness Area had 22,100 visitor days of use. The Upper Rio Grande Primitive Area, which was included in the Weminuche Wilderness in 1975, received 36,900 visitor days of use the same year. Assuming local expenditures of \$5.60 per visitor day, the resulting \$330 thousand indicates the direct wilderness benefit to the basin.

Hunting expenditures per visitor day (based on Doll, G. F. and C. Phillips, 1972, Wyoming's Hunting and Fishing Resources, 1970, University of Wyoming, Laramie, WY.) in 1972 for service stations, restaurants, lodging, retail trade, licenses, etc., for various hunting and fishing experiences are estimated at:

Deer	\$10.75
Elk	17.25
Small game	8.50
Game birds	15.00
Fish	5.50

Using these data, the estimated expenditures related to hunting in the basin approximates 14.6 million. These expenditures directly affect the retail and service industries of the basin, in which nearly 30 percent of the work force is employed.

4. Employment

A critical aspect of the basin's economy is the lack of employment for the basin's labor forces. To bring this into better perspective, a series of tables were developed in which all the labor forces are matrixed by industry and occupation.

On the one hand Table F-2 (sheets 1-3 of 6, Appendix F) portrays the total number of people, the number of women and number of minority individuals employed in 1974 in the entire basin. These tables present some insight as to who is employed where in the basin. Also Table F-2 (sheets 4-6 of 6, Appendix F) was developed to present the same information but for the seasonal employment which is also critical in the basin's economy.

Using these tables as a base, one can compile employment information for any industry/occupation sector or any combination thereof, in the basin. For instance, to determine what occupations and how many people in each occupation were involved in the timber industry in 1974, a simple Table V-11 can be constructed.

TABLE V-11

EMPLOYMENT IN THE TIMBER INDUSTRY

(1974)

Rio Grande Basin, Colorado

OCCUPATION	INDUSTRY		
	Logging Contractors	Sawmills & Treating Plants	Construction
Professional and Technical	0	0	17
Managers and Administrators	8	11	45
Sales	0	1	2
Clerical	0	5	9
Craftsmen, Foremen, and Mechanics	25	25	120
Operatives	16	63	24
Service Workers	0	5	5
Laborers	2	39	33
TOTAL	51	149	255

About 2 percent of the basin's work force is involved directly and indirectly with the timber industry. Those working in the sawmills and treating plants, and logging contractors are considered directly employed, while some of the people in the construction sector would be employed indirectly. Nearly all timber industry employees work year-around with only a short lay-off period in the winter.

Similarly one can show that approximately 1,030 people are employed year-around in the livestock industry. An additional 515 are employed seasonally, predominately in late summer.

D. Present Environmental Situation

To date, two wilderness areas have been declared--La Garita with 22,458 acres (9,089 ha) and the Weminuche with some 127,151 acres, (51,458 ha) the latter encompassing the former upper Rio Grande primitive area. Additionally, by 1973 four roadless areas were under study for inclusion in the wilderness system. These defacto wilderness areas total some 230,191 acres (93,158 ha). Similarly, nine inventoried roadless areas, totalling some 233,729 acres (94,590 ha), have not yet been selected for further wilderness study. Because of planning procedures and administrative dictates, some, all, or parts of these may be selected for further study in the future, recommended for wilderness designation or returned to multiple-use, non-wilderness uses.

Interference with big game migration routes and loss of winter range in the basin is of environmental concern. The basin is the home of some 8,000 mule deer and 8,500 elk in addition to several other big game species. Available winter forage to feed these herds is critical. Of about 770,000 acres (311,619 ha) of deer and elk winter range in the basin, 40 percent is on non-public lands. Approved and proposed subdivision development has already paved the way for the eventual removal of over 85,000 acres (34,400 ha) of winter range in the private sector through human influence or permanent loss by construction.

Linear subdivision development is likely to occur along the Rio Grande from Alamosa to Creede unless stringent regulation of development is imposed. Without regulation the western portion of the Rio Grande Basin would be effectively bisected with a band of human populace running generally east-west following the river and highways. This problem is particularly important in the Del Norte-South Fork-Creede strip, where major big game migration routes cross the Rio Grande in a north-south pattern. In essence winter forage would be present, but if the migratory routes are intercepted, it would be inaccessible to the migrating herds. Cutting off these migration routes is not entirely possible since private land forms practically a solid strip along the Rio Grande.

Measures to protect endangered and threatened wildlife species in the basin consist of maintaining or promoting known appropriate habitat for the affected species: these include preserving prairie dog populations (important for the black-footed ferret); remote timbered areas are vital to the wolverine; nesting areas of the peregrine falcon, should be free from intensive human activity and pesticides; preserving wetlands to maintain habitat for classified waterfowl.

The Rio Grande cutthroat trout is the only fish species considered threatened. Its decline is attributed to water pollution, water diversion for irrigation and competition from introduced trout.

Two plant species, the alkali bluegrass and bigelow sage, fall into the proposed endangered or rare categories. Their decline is caused primarily by human activities that destroy or deteriorate their habitat.

Forest harvesting on both public and private ownerships is generally compatible with environmental quality. Few steep slope operations are underway requiring cable systems. Natural regeneration of some harvested areas on the Rio Grande National Forest has not been adequate, and there is now a reforestation backlog. Stagnated young stands in need of timber stand improvement also exist on the national forest.

Trends toward sprinkler irrigation have created idle cropland areas in field corners of center pivot systems. These areas provide food and cover for wildlife.

Windbreaks and shelter belts are nonexistent on the basin floor because trees and shrubs need irrigation to survive. At the same time, it is beneficial to drain some lands for crop production, however, drainage may eliminate wetland wildlife habitat.

Other land, water and air environmental conditions are addressed under their respective sections in previous chapters.

E. Projections and Preferences

1. General Methods

Prognosticating future alternative conditions and goals is at best an inexact technique subject to revision as more adequate information becomes available. Still, projections and preferences are necessary to help establish objectives.

The primary document utilized for guidance in projections was the Water Resources Council's OBERS projections of economic activity in the United States. These projections are based mainly on historical data. Two series of OBERS demand projections have been developed--the series C and E, each based on forecasted population growth. A series E' was generated

for agricultural projections which were based on series E population estimates, but compensated for changes in export, domestic consumption, and crop yield patterns.

The population estimates of the E series through a five-decade period beginning in 1976 is seen as:

Decade Midpoint (year)	U. S. Population (million people)
1980	223.5
1990	246.0
2000	263.8
2020	297.1

The higher series C estimates show a U. S. population of 400 million by year 2020.

Given projected national demands under each series, these were disaggregated to each geographic area and assigned an allocation of this demand for each series. WRC's Principles and Standards advise the determination of alternative plans for a basin's ability to meet its allocation under each projection. This was not the case for the Rio Grande Basin; it could not meet its allocation under the lower series E' projections and, therefore, it would have been futile to attempt to meet any higher projected demands.

Not all problem-related projected demands or allocations, such as for wilderness, could be ascertained directly from OBERS. In those cases allocations were determined from other sources available and correlated to OBERS population estimates. Also, some demand factors cross-cut more than one problem area. For instance, crop production demand projections encompassing numerous individual crops are affected by many of the identified problems in Chapter III. In those cases related problems and demands were grouped.

Obviously, many environmental conditions escape quantification. Situations of that nature were verbally described as what would be ideally environmentally preferred. In some cases, such as for forest environs, several environmental quality indices were developed, each involving a spectrum of related parameters.

The environmental quality evaluation system developed for federal forest and range lands of the Rio Grande is produced on a scale of zero to one hundred--the higher the index value, the better the environmental quality. These quality indices

were developed for five categories--water; development and use; wildlife; esthetics; and total quality, an overall average of these five indices.

Since any one value for any one index is based on numerous parameters attaining a maximum of 100 is not probable; reaching a low of zero is also not likely, so maximizing each category, the following are upper value limits:

water quality -------------------- 91
development & use quality --------- 74
wildlife quality ------------------ 64
esthetic quality ------------------ 75
total quality -------------------- 76

Each value represents the highest quality attainable in the Rio Grande analysis of forest lands and represents the environmental preference of those lands for the future.

2. Agricultural Production OBERS Comparisons

In 1972 OBERS series E' projections, released by the U. S. Water Resources Council, were incorporated into the study analyses as benchmarks for agricultural production. These projections are not to be construed as production goals, however. The assumptions underlying the OBERS series E' projections are documented through the Water Resources Council.

The objectives of the OBERS program are the development and maintenance of (1) a regional economic information system with provisions for rapid and flexible data retrieval; (2) near term (1980-1990), mid term (2000) and far term (2020) projections of population, economic activity, and land use for the nation and its geographic subdivision; and (3) special analytical systems designed for use in water resources and other public investment planning.

In short, the OBERS projections were developed with the notion of nationwide consistency. The OBERS E' projections pertain to agricultural commodities, along with forest products, and were developed using recent information concerning domestic demand and foreign export.

Table V-12 lists the OBERS projected production allocation for national demands for the various commodities produced in the basin alongside the projected production associated with the without plan situation (continuation of on-going programs only), the NED plan, EQ plan and the Alternate plan. It

should be pointed out that the barley projections listed under OBERS include a combination of feed barley projected by OBERS and additionally malting barley projections developed independently by Coors Brewing Company.

In terms of value of production based upon 1974 established Water Resources Council prices, the OBERS projections exceed the without plan projections by about nine million dollars in 2000 and nearly 15 million dollars in 2020. OBERS exceeds the NED plan projections by over four million dollars in 2000 and over seven million in 2020, the alternate plan by nearly five million dollars in 2000 and over nine million dollars in 2020 and finally the EQ plan by over ten million dollars in 2000 and nearly 16 million in 2020.

Again, it is emphasized that the OBERS projections are not meant as goals but rather benchmarks for comparison. Under the existing restrictions of the Rio Grande compact and associated water storage limitations and with yield, price and cost assumptions utilized in the plan projections, meeting production levels of all the OBERS agricultural commodity allocations in the study area would not appear to be an economic reality in 2000 or 2020.

3. Economic Projections, Environmental Preferences and National Objectives

Depending on the problem and adequacy of information available, projections are given on an annual basis for various forecast periods in ten-year increments beginning with year 1980 through 2020. All projections will, however, fall within this five-decade planning realm actually starting in 1976 and ending in 2025. Projections represent a decade midpoint; in other words, a 1990 production projection would indicate the average annual production through the ten-year planning interval of 1986-1995.

As mentioned earlier, substantial interaction of projections, preferences, national objectives and problems occurs. By combining logical relationships, the presentation is greatly simplified by avoiding repetition. Where no quantified data can be listed, the projection or preference is stated verbally in a descriptive manner. Table V-12 presents all the national objectives and local problems in relation to their economic projections and environmental preferences.

TABLE V - 12

CORRELATION OF OBJECTIVES AND PROBLEMS TO PROJECTIONS AND PREFERENCES
Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	LOCALLY CONCEIVED PROBLEMS
NED 1	Inadequate water for late season irrigation.
NED 2	Over-appropriation of streamflow and withdrawals for Rio Grande compact.
NED 3	Inefficient irrigation and deliver system.
NED 4	Inadequate drainage.
NED 5	Flooding.
NED 6	Low inherent fertility and organic matter.
NED 7 EQ 1	Wind Erosion.
NED 8	Noxious weed control.
NED 9	Limited range of crops
EQ 3	Water pollution from mine drainage and agricultural runoff.

ECONOMIC DEMAND PROJECTIONS AND ENVIRONMENTAL PREFERENCES

OBERS E' Basin Allocation - Crop Production

Food & Fiber	Unit	Year 1990	Year 2000	Year 2020
Oats	bu (m^3)	416,300 (14,670)	442,200 (15,583)	424,300 (14,952)
Spring Wheat	bu (m^3)	133,000 (4,687)	142,200 (5,011)	136,400 (4,807)
Winter Wheat	bu (m^3)	26,200 (923)	28,000 (987)	26,900 (948)
Barley Feed	bu (m^3)	694,800 (24,484)	737,400 (25,985)	707,500 (24,932)
Barley Malt	bu (m^3)	6,880,100 (242,448)	8,592,000 (302,774)	11,877,000 (418,534)
Hay Alfalfa	ton (t)	200,500 (181,854)	214,100 (194,189)	205,400 (186,298)
Hay Small Grain	ton (t)	10,700 (9,705)	11,400 (10,340	11,000 (9,977)
Hay Grass	ton (t)	141,200 (28,068)	148,300 (134,508)	142,300 (129,066)
Potatoes	cwt (kg)	9,772,200 (443,266,992)	10,436,000 (473,376,960)	10,012,000 (454,144,320)
Vegetables	Ac (ha)	6,400 (2,590)	6,400 (2,590)	6,400 (2,590)
Idle Crops	Ac (ha)	32,900 (13,315)	32,900 (13,315)	32,900 (13,315)
Crop Failure	Ac (ha)	3,800 (1,538)	3,700 (1,497)	3,700 (1,497)
Minor Crops	Ac (ha)	2,100 (850)	2,100 (850)	2,100 (850)

Environmental preference is to: Eliminate any excessive wind erosion and water pollution; improve soil fertility; overall soil cover and organic matter; expand range of crops, reduce flood hazards.

NATIONAL OBJECTIVES	LOCALLY CONCEIVED PROBLEMS	ECONOMIC DEMAND PROJECTIONS AND ENVIRONMENTAL PREFERENCES
NED 10 NED 12 NED 14	Inadequate rural electrification, sanitation, and housing.	Although population estimates show a moderate increase overall, this would only tend to aggravate these inadequacies in the future as demands for in all sectors increase.

NED 11 — Underdeveloped range resources, overgrazing.

OBERS E' Basin Allocation - Range and Pasture

Year	Animal Unit Months
1990	1,880,100
2000	2,092,600
2020	2,504,700

NED 13 — Inadequate municipal water supply.

Demand for Municipal Water (16 Communities)

Year	Gallons	Liters
1980	7,615,000	28,825,621
2000	12,287,900	46,514,617

TABLE V - 12

(Contd)

CORRELATION OF OBJECTIVES AND PROBLEMS TO PROJECTIONS AND PREFERENCES
Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	LOCALLY CONCEIVED PROBLEMS	ECONOMIC DEMAND PROJECTIONS AND ENVIRONMENTAL PREFERENCES
NED 15 EQ 2	Lack of recreational areas and facilities.	OBERS E' Basin Allocation - Developed Recreation
NED 18	Fluctuating utilization of recreation resources.	

Thousand Visitor Days	Year 1980	Year 2020
Camping	336	1,053
Picnicking	167	463
Subtotal	503	1,516
National Park	79 (c)	79 (c)
Skiing	96 (c)	96 (c)
Total	599	1,612

(c) Remains constant

Environmentally, over-utilization of recreaction resources sho should be eliminated, thereby reducing side degradation and allowing better management.

TABLE V - 12

(Cont'd)

CORRELATION OF OBJECTIVES AND PROBLEMS TO PROJECTIONS AND PREFERENCES
Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	LOCALLY CONCEIVED PROBLEMS	ECONOMIC DEMAND PROJECTIONS AND ENVIRONMENTAL PREFERENCES
NED 16 EQ 7	Inadequate access to public land for recreation, hunting and fishing.	As demands for recreation resources increase, pressures to utilize presently inaccessible areas will also increase. Low cost and expeditious procurement of right-of-way to fully utilize all public recreational resources is economically preferred, while access systems should be developed only to the extent necessary to be compatible with resource use.
NED 17	Insufficient timber supply to operate existing mills at capacity; current level of timber management will not allow basin's resources to contribute their share of nation's future needs; significant mortality in over mature and significant stagnation in immature timber stands.	OBERS E' Basin Allocation - Timber Year / Million Board Feet 1980 / 60 1990 / 76 2000 / 82 2010 / 83 2020 / 84
EQ 4	Opportunities for scientific investigation and recreation in wilderness setting may be significantly diminished.	Basin Allocation - Wilderness Recreation Year / Visitor Days Wilderness 2020 / 796,800 Backcountry 2020 / 531,200 Total 2020 / 1,328,000
EQ 5 EQ 6	Decreasing big game winter range and migration routes threatened by urban development.	Maintain present winter range area 771,030 acres, (312,036 ha), and big game migration routes, but increase big game forage production on winter range to attain maximum big game animal unit months (115,480) by foregoing all livestock grazing on winter range.
EQ 8	Degradation of trout habitat due to siltation of streams by road construction and timber harvest activities.	Initiate and accelerate management practices that minimize erosion from road construction and timber harvesting; reduce amount of raod; restrict off-road vehicles.
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	Avoid extinction of the species by maintaining their habitat; taking such measures as necessary to increase their numbers and improve their habitat; reintroducing those species known to have inhabited the area; and pursuing land management programs compatible with the propagation of the affected species
EQ 10	Smoke from sawmill burners degrades air quality.	Dispose of sawmill wastes by modification and further processing into useable products to avoid burning.

CHAPTER VI

FUTURE WITHOUT CONDITION

CHAPTER VI - FUTURE WITHOUT CONDITION

A. Definition and Purpose

The "future without" condition is that projected situation which best represents conditions resulting from continuation of ongoing state and federal programs in conjunction with private efforts. In essence it is a descriptive plan displaying outputs and conditions resulting at some future time from direction and effects of present functional plans and active projects.

Included under functional plans would be such documents as timber management plans for a national forest, state forest management plans within the area, resource area management plans of federal agencies, and state, local and private cooperative planning efforts for recreation, wildlife, environment, etc. Active projects include those of any federal, state or local agency, currently in progress, for which funds have been appropriated; or for which construction has been authorized. Projects included in this category are the Trinchera Watershed, Del Norte Recreation measure, and the Closed Basin Division-San Luis Valley Project Colorado.

One reason for establishing a future without condition is to set a base-line to which other alternative plans of the basin can be compared. This will be done in Chapter VIII. Yet another function of the future without is to aid in determining and quantifying needs as developed in Chapter VII.

Once projected national demands (OBERS, etc.) have been disaggregated to the basin allocations, future without projections show whether or not these allocations will be met under current directives and plans. Comparing these projected allocations of Chapter V with projected production under future wihtout reflects the needs, as they were derived in Chapter VII. Formulation of alternative plans to meet those needs not fulfilled by future without is the basis for Chapter VIII. It is emphasized that their needs are based on OBERS allocations which are meant as standards of comparison and not mandated demand goals.

B. Assumptions

Any projection is a conditional forecast of the future based upon stated assumptions about factors that are expected to impact future conditions. Projections, therefore, are only as valid as the assumptions upon which they are based.

To facilitate the analysis, the land resources of the Rio Grande Basin were divided into two aspects. State and private range and cropland were analyzed with the Agriculture Linear Programming Model. All

federal land together with non-federal forest land was analyzed in the Forest Linear Programming Model. The two models were correlated to provide consistent range and water outputs.

The nonfederal range and cropland category, consisting of state, private and municipal lands, required analysis mainly from the viewpoint of short term planning on an annual basis, since land use can be altered annually for most crops. In contrast, planning for forest lands (federal, state and private) necessitates long range planning because of long harvest rotations and to assure sustained yield management; whether the crop is harvested in any one particular year is not a critical concern. In this case, a decade planning interval sufficed. With these basic differences in mind, the overall future without condition, as well as other plans formulation in Chapter VIII, evolved around these two basic elements.

1. State and Private Range and Cropland

Base year (1970-1972) acreages yields and production were taken from Colorado Agricultural Statistics and the 1968 USDA Conservation Needs Inventory. The figures were slightly modified in some cases to more accurately reflect existing conditions. Soil association cropping patterns and yield data, developed by soil survey interpretations and estimates of Soil Conservation Service personnel located in the basin, were normalized using 1970-1972 Statistical Reporting Service county data and the 1969 U. S. Census of Agriculture.

Future without alternative prices were held constant at 1974 normalized prices for all time periods. Projected crop, pasture and range yields were developed using yield projection indices. Projected acreages were developed by dividing projected production by the projected yields.

In addition to these projection techniques, some basic assumptions regarding state and private non-forest lands were:

The continuation of land sales on platted developments, subsequent construction and the human habitation will bring commercial livestock grazing down to an insignificant level on private range land. It will also eliminate the use of about 85,000 acres (34,400 ha) of deer and elk winter range.

The San Luis Valley Council of Governments' population projection of 7,100 people by 2000 for South Fork is correct. Associated development will string out along the riverbottoms and main roads and will have serious impacts on deer and elk migrations between summer and winter range.

Determinations of water pollution problems and quantities will consider Public Law 92-500 and its effects on water pollution.

Watershed projects, RC&D measure plans and other projects not authorized for implementation were not included in the future without conditions.

The Rio Grande Water Compact will remain in effect.

The habitat of the black-footed ferret, which is typically in prairie dog towns, will continue to decline due to eradication on private land, but increase on public lands.

2. Federal and Forest Land

Based on current plans, statistics and informational coordination meetings, assumptions constructed around the future without condition for these lands were:

Timber harvest will increase rapidly from historical levels with much greater emphasis on private timber. Major planting and thinning operations will occur on national forest land through the next two decades, but none will be initiated on state and private land.

No timber management will be directed specifically at increasing water yield.

Timber harvesting from private land will be with the assistance of the State Forester and accomplished in an environmentally acceptable way. That is, harvest areas will be moderate in size (less than 10% of a drainage area), skid trails and temporary roads will be waterbarred and revegetated, permanent roads will have ditches with drainage pipes properly spaced and located. The result will be no significant impact on the Rio Grande Cutthroat Trout habitat.

Forage production on national forest and natural resource lands will increase significantly from 1980 to 2020 due to intensified management.

No specific improvements for big game winter range areas will be undertaken; increased forage production will occur only with associated livestock range improvement measures.

In addition to the two existing wilderness areas, four roadless areas selected as new wilderness study areas (Snow Mesa-Bristolhead, 12,160 ac. [4,921 ha]; Zapata, 30,080 ac. [12,173 ha]; Sangre de Cristo, 71,107 ac. [28,777 ha]); Chama South San Juan, 116,844 ac. [47,287 ha]); will be managed as wilderness. The nine remaining roadless areas will be developed and contribute to the timber harvest.

The recovery plan for the peregrine falcon has been approved but funding for the implementation of the recommendations will be less than optimal. Black-footed ferret habitat will be unchanged, the presence of ferrets will remain undetermined.

It is not known whether there are any wolverines, gray wolf, grizzly bear, river otter, or lynx in the basin. They are all believed to have been past residents. No specific measures have been prescribed for the future welfare of any of these animals that may yet exist in the area. For the wolverine, wolf, bear and lynx it is thought that the less development that occurs on forest land in general, and on wilderness or roadless areas specifically, the greater will be the opportunity for successful reintroduction. For the otter the maintenance of streams with high water quality supporting viable populations of fish and crustaceans seems to be the key to future populations. It is assumed that the future of these animals is one of dissappearing habitat.

Developed recreation facilities (camping, picnicking) are adequate to handle projections of use through 1980. An additional 26 acres (11 ha) will be developed on national forest lands by 2020 to accomodate projected use by that time. In general, efforts from all sectors will be directed at improving quality rather than quantity of facilities.

C. General Description of Projection

1. Crop Production

Series E' crop projections indicate an increase in crop production and value until 2000 after which there is a decline. Production and value of malting barley based on localized rather than series E' projections increases throughout the projection period. The projected crop acreages fluctuate in the series E' projections due to variations in relative yields. For most crops, projected series E' acreages increase until 1980 and decline thereafter. Malting barley,

based upon localized projections shows an acreage increase throughout the projections. Acreage production and value of all range and pasture sources indicate declines to 1980 but increases thereafter.

There is a great potential for increased production through the use of better management of cropland and water resources. The use of modern agricultural technology would help to increase yield and total production. Also, a potential to transfer land from irrigated pasture to irrigated cropland is available as demand for the various crops increases.

The projected increase in agricultural products in the Rio Grande Basin would produce a corresponding increase in agricultural exports from the region since the population growth in the region is moderate in numbers.

2. Water Resource

The projects which supply additional irrigation water are Trinchera Watershed, Del Norte Recreation Measure and Closed Basin Division-San Luis Valley Project, Colorado.

3. Forage Production

National forest range land available for meat production is expected to decrease in total area as more acreage is allocated for recreation animal grazing and other uses. Production from the decrease in total area will probably be offset by more intensive management of the remainder of the range land to increase productivity by fencing and water development to control stock distribution. Natural resource lands would have a similar trend except that recreation livestock will create a lesser impact.

4. Timber Production

The Rio Grande National Forest carries the bulk of present as well as future timber production, assuming that funding takes place commensurate with the projections. Even with adequate funding to attain the future without plan levels, total production falls well below OBERS E' demand projections.

Of the Federal agencies, the Forest Service will have a major planting operation to eliminate a large backlog of acres needing reforestation. During the same period, precommercial thinning of a backlog of overstocked stands will be a major effort; it was estimated that subsequent precommercial thinning should amount to about ten percent of the respective period's harvested acres. Commercial thinning acres depend greatly on market conditions.

Timber production operations on natural resource lands have been relatively minor in the past and even with increased emphasis on timber, the resource base is such that it will be least significant of all the ownerships.

5. Recreation

Wilderness and backcountry recreation per se, is unique to national forest lands in the basin. The Weminuche and La Garita Wildernesses have been designated as such. Four of thirteen roadless areas are presently designated for further study for possible inclusion in the wilderness system (Table VI-1). It can only be surmised which status the roadless areas will ultimately attain, but it is assumed here that the study areas will become wilderness while the remainder of the roadless areas will assume backcountry status or revert to multiple-use management. Backcountry recreation is defined here as non-vehicular recreation use at a rate greater than that suitable per the 1964 Wilderness Act.

Developed recreation areas (campgrounds, ski areas, etc.) on natural resource lands have been, and will continue to be, insignificant in the foreseeable future.

Wolf Creek Ski Area

State developed recreation areas are limited to those under the Division of Wildlife at La Jara and Coller State Park. These areas, as well as the Great Sand Dunes National Monument, encompass relatively large areas. With increased quality of recreation rather than quantify foreseen; use is somewhere between an intensively developed campground and dispersed type recreation. Recreation is envisioned as utilization on these areas, they are assigned the developed recreation category, with the output (visitor day/acre/year) ultimately showing the use intensity.

Private campground facilities are assumed to increase to fill in the gap between an essentially static public supply and the increasing demand.

D. Specific Description of Future Without Conditions

The specific NED and EQ related objective components identified and their relationship to the Future Without Conditions are shown in Table VI-2.

Table VI-1

WILDERNESS STUDY AND ROADLESS AREAS - 1973
Rio Grande Basin, Colorado

WILDERNESS AREAS:	Acres	Hectares
Weminuche	127,151	51,458
La Garita	22,458	9,089
Sub-total	149,609	60,547
STUDY AREAS:		
Snow Mesa-Bristol Head	12,160	4,921
Zapata	30,080	12,173
Sangre de Cristo	71,107	28,777
Chama-South San Juan	116,844	47,287
Sub-total	230,191	93,158
OTHER ROADLESS AREAS:		
Wheeler-Wason	62,691	25,371
Pole Mountain	52,825	21,379
Snow Mesa-Bristol Head	31,305	12,669
Bennett Peak	27,600	11,170
Willow Mountain	21,150	8,559
Lake Fork-Saguache Creek	5,338	2,160
Fox Mountain	6,810	2,756
Saguache Creek	13,905	5,627
Sheep Creek	12,105	4,899
Sub-total	233,729	94,590
GRAND TOTAL	613,529	248,295

TABLE VI-2

OBJECTIVES, PROBLEMS AND FUTURE WITHOUT CONDITIONS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	SOCIAL PROBLEMS
NED 1	Inadequate water for late season irrigation.
NED 2	Overappropriation of streamflow, withdrawals for Rio Grande compact.
NED 3	Inefficient irrigation and delivery system.
NED 4	Inadequate drainage.
NED 5	Flooding.
NED 6	Low inherent fertility and organic matter.
NED 7 Eq 1	Wind Erosion.
NED 8	Noxious weed control.
NED 9	Limited range of crops.
EQ 3	Water pollution from mine drainage and agricultural runoff.

FUTURE WITHOUT PROJECTIONS AND ENVIRONMENTAL CONDITIONS

Future Without-Crop Production Values

Food & Fiber	Unit	Year 1990	Year 2000	Year 2020
Oats	bu (m3)	416,300 (14,670)	442,200 (15,583)	424,300 (14,952)
Spring Wheat	bu (m3)	57,000 (2,009)	67,200 (2,368)	63,100 (2,224)
Winter Wheat	bu (m3)	12,000 (423)	12,000 (423)	10,100 (356)
Barley Feed	bu (m3)	694,800 (24,484)	737,400 (25,985)	707,500 (24,932)
Barley Malt	bu (m3)	6,459,300 (227,620)	7,964,400 (280,658)	9,945,500 (350,470)
Hay Alfalfa	ton (t)	100,500 (91,154)	114,100 (103,489)	95,400 (86,528)
Hay Small Grain	ton (t)	10,200 (9,251)	10,400 (9,433)	11,000 (9,977)
Hay Grass	ton (t)	101,200 (91,788	108,300 (98,228)	102,200 (92,695)
Potatoes	cwt (kg)	9,772,200 (433.266,992)	10,436,000 (473,376,960)	10,012,000 (454,144,320)
Vegetables	Ac (ha)	6,400 (2,590)	6,400 (2,590)	6,400 (2,590
Idle Crops	Ac (ha)	32,900 (13,315)	32,900 (13,315)	32,900 (13,315)
Crop Failure	Ac (ha)	3,700 (1,497)	3,700 (1,497)	3,700 (1,497)
Minor Crops	AC (ha)	2,100 (850)	2,100 (850)	2,100 (850)

Environmentally, there is no indication that positive action will be taken to reduce wind erosion, lessen pollution, and increase soil fertility, cover and organic matter; flood hazards will be reduced to some degree by ongoing projects, but no direct action taken; the range of crops will remain essentially the same as present.

NATIONAL OBJECTIVES	SOCIAL PROBLEMS	FUTURE WITHOUT PROJECTIONS AND ENVIRONMENTAL CONDITIONS
NED 10 NED 12 NED 14	Inadequate rural electrification, sanitation and housing.	Plans show no rapid advancement for electrification beyond present rate; the need for transmission lines for pivot systems could increase; plans for upgrading sanitation systems have been completed, but whether implementation occurs is questionable; there is no indication that housing conditions will improve anymore rapidly in the future.

NED 11 — Under-developed range resources; overgrazing.

Future Without-Production for Range & Pasture

Year	Animal Unit Months
1990	1,655,100
2000	1,676,200
2020	1,732,000

NED 13 — Inadequate municipal water supply.

Future Without-No Expansion of Water Supply - 16 Communities

Year	Gallons	Liters
1980	7,287,300	27,963,886
2000	7,287,300	27,963,886

TABLE VI-2

Cont'd
OBJECTIVES, PROBLEMS AND FUTURE WITHOUT CONDITIONS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	SOCIAL PROBLEMS	FUTURE WITHOUT PROJECTIONS AND ENVIRONMENTAL CONDITIONS
NED 15 EQ2	Lack of recreational areas and facilities.	Future Without-Developed Recreation Year — Thousand Visitor Days/Year 1980 — 1,555 2020 — 1,605
NED 18	Fluctuating utilization of recreation resources.	No change of direction is evident that working hours or vacation times will be altered to the extent necessary to appreciably affect utilization characteristics.
NED 16 EQ 7	Inadequate access to public land for recreation, hunting and fishing.	Although some emphasis is being placed on obtaining right-of-ways more expeditiously, there is no evidence to show lower cost procurement or gaining access by means other than through land management activities related to these uses.
NED 17	Insufficient timber supply to operate existing mills at capacity; current level of timber management will not allow basin's resources to contribute their share of nation's future needs; significant mortality in over mature and significant stagnation in immature timber stands.	Future Without-Timber Production Year — Million Board Feet (Log Scale) 1980 — 31 1990 — 42 2000 — 50 2010 — 55 2020 — 70
EQ 4	Opportunities for scientific investigation and recreation in wilderness setting may be significantly diminished.	Future Without-Available Wilderness Recreation — Year — Visitor Days Wilderness — 2020 — 42,000 Backcountry — 2020 — 0 Total — 2020 — 42,000
EQ 5 EQ 6	Decreasing big game winter range and migration routes threatened by urban development	Development trends in the Basin, if continued, would decrease the effective winter range area by at least 85,000 acres (34,400 ha), but more intensive management of the remaining area would allow the big game herds to be maintained with the 48,400 big game animal unit months of forage still available. Concurrent with the decline of the winter range area, however, will be the reduction of migration routes by linear subdivision and increased road construction. One can not assume that, since fewer or equal numbers of big game animals would exist, there is less concern for maintaining migration routes - the combined effects of loss of winter range in one area and migratory routes to the remaining winter range in another area could multiply the impacts.
EQ [illegible]	Degradation of trout habitat due to situation of streams by road construction and timber harvest activities.	If assumptions are near correct, no further degradation will take place on private lands. Public land management practices themselves may not further aggravate siltation; however, resource damage from increased off road vehicle use may not allow the situation to improve on public lands.

TABLE VI-2

Cont'd
OBJECTIVES, PROBLEMS AND FUTURE WITHOUT CONDITIONS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	SOCIAL PROBLEMS	FUTURE WITHOUT PROJECTIONS AND ENVIRONMENTAL CONDITIONS
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	With an approved recovery plan for the paragrine falcon, positive efforts will continue for this species, but funding for program implementation is not likely to be adequate. Since one of the habitat requirements of the black-footed ferret is prairie dog towns, it can be expected that on private lands this segment of its habitat will decline because of prairie dog eradication programs. On public lands no special action is planned to preserve or destroy the prairie dog, so it can be surmised that its habitat will generally remain unchanged from the present. Adequate habitat for the larger mammals on the Endangered and Threatened list (wolverine, gray wolf, grizzly bear and lynx) would probably be provided by the 380,000 acres (153,786 ha) of wilderness areas assumed under future without plan conditions. These acres would allow propagation of the species, if present, or restocking if no species remain. Drainage of any wetlands will remove habitat acres for the greater sandhill crane, whooping crane, Mexican duck and river otter. While water impoundments constructed under this condition will have some beneficial effects for some species, the shallow water environment lost through land reclamation projects can not be offset. Only the 23,000 (9,308 ha) acres of the U. S. Fish and Wildlife Service's Refuges at Alamosa and Monte Vista can be certain of wetland preservation.
EQ 10	Smoke from sawmill burners degrades air quality.	The State Air Pollution Control Commission will issue new emission standards in 1978 which will allow opacity reduction greater than 20% only during start-up and shut-down periods. Sawmills will either quit burning or install adequate burners.

CHAPTER VII

NEEDS

CHAPTER VII - NEEDS

Needs, as perceived by the Water Resources Council's Principles and Standards, are the differences between the basin's share of projected national demands and environmental preferences as presented in Chapter V, and the basin's projected outputs and environmental effects of the future without condition developed in Chapter VI.

The needs displayed in Table VII-1 represent those differences in demands, preferences and outputs as related to Tables V-12 and VI-2. They are displayed in tabular format, correlating the national objectives and locally-perceived problems to needs. Needs, then, would indicate what degree of resource treatment, if any, is necessary to achieve components of the objectives as conceptualized in Chapter III, Tables III-4 and III-5.

TABLE VII-I
OBJECTIVES, PROBLEMS AND NEEDS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	LOCALLY - PERCEIVED PROBLEMS
NED 1	Inadequate water for late season irrigation.
NED 2	Overappropriation of streamflow; withdrawals for Rio Grande compact.
NED 3	Inefficient irrigation and delivery system.
NED 4	Inadequate drainage.
NED 5	Flooding.
NED 6	Low inherent fertility and organic matter.
NED 7 EQ 1	Wind Erosion.
NED 8	Noxious weed control.
NED 9	Limited range of crops.
EQ 3	Water pollution from mine drainage and agricultural runoff.

NEEDS - PROJECTED DEMANDS AND PREFERENCES NOT SATISFIED BY FUTURE WITHOUT PROJECTIONS

Needs - Crop Production

Food and Fiber	Unit	Year 1980	Year 2000	Year 2020
Oats	bu (m3)	0 (0)	0 (0)	0 (0)
Spring Wheat	bu (m3)	76,000 (2,678)	75,000 (2,643)	73,300 (2,583)
Winter Wheat	bu (m3)	14,200 (500)	16,000 (564)	16,800 (592)
Barley Feed	bu (m3)	0 (0)	0 (0)	0 (0)
Barley Malt	bu (m3)	420,800 (14,829)	627,600 (22,116)	1,931,500 (68,064)
Hay Alfalfa	ton (t)	100,000 (90,700)	100,000 (90,700)	110,000 (99,770)
Hay Small Grain	ton (t)	500 (454)	1,000 (907)	0 (0)
Hay Grass	ton (t)	40,000 (36,280)	40,000 (36,280)	40,100 (36,371)
Potatoes	cwt (kg)	0 (0)	0 (0)	0 (0)
Vegetables	Ac (ha)	0 (0)	0 (0)	0 (0)
Idle Crops	Ac (ha)	0 (0)	0 (0)	0 (0)
Crop Failure	Ac (ha)	0 (0)	0 (0)	0 (0)
Minor Crops	Ac (ha)	0 (0)	0 (0)	0 (0)

Greater positive action is required to subdue wind erosion, water pollution and increase soil fertility, cover and organic matter. Intensive research is needed to investigate introduction of additional crops; accelerated flood control projects are necessary to reduce flood hazards. Revisions of water use and allocation procedures and legal aspects are required to alleviate overappropriation and continue to meet compact agreements. Local level government and agencies must be more aggressive in initiating action plans.

NED 10
NED 12
NED 14

Inadequate rural electrification, sanitation and housing.

Conflicts of jurisdiction for electrification must be resolved expeditiously so programs can be implemented as needs arise for irrigation and housing; since a sanitation plan exists, implementation is of the essence; a plan to provide adequate housing is paramount.

NED 11

Underdeveloped range resources; overgrazing.

Needs - Range and Pasture Production

Year	Animal Unit Months
1990	225,000
2000	416,400
2020	772,700

Intensified range management practices need to be invoked.

NED 13

Inadequate municipal water supply.

Needs - Water Supply - 16 Communities

Year	Gallons	Liters
1980	327,700	1,240,476
2000	5,000,600	18,929,271

TABLE VII-I
(Contd)

OBJECTIVES, PROBLEMS AND NEEDS

Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	LOCALLY - PERCEIVED PROBLEMS	NEEDS - PROJECTED DEMANDS AND PREFERENCES NOT SATISFIED BY FUTURE WITHOUT PROJECTIONS
NED 15 EQ 2	Lack of recreational areas and facilities.	Needs - Developed Recreation Year — Thousand Visitor Days/Year 1980 — 0 2020 — 7 More equal distribution of area and facility utilization is needed to prevent overuse and resource damage.
NED 18	Fluctuating utilization of recreation resources.	
NED 16 EQ 7	Inadequate access to public land for recreation, hunting and fishing.	Changes in land management policies and legal procedures are needed to reduce costs and expedite obtaining rights-of-way; area access should be dictated by use need rather than by conjunctive use financing.
NED 17	Insufficient timber supply to operate existing mills at capacity; current level of timber management will not allow basin's resources to contribute their share of nation's future needs; significant mortality in over mature and significant stagnation in immature timber stands.	Needs - Timber Production Year — Million Board Feet (Log Scale) 1980 — 29 1990 — 34 2000 — 32 2010 — 28 2020 — 14 More aggressive reforestation and thinning operations must be initiated; private timber management needs to be promoted; and public forest management practices need to be intensified.
NED 18	See NED 15	
EQ 1 EQ 2 EQ 3	See NED 7 See NED 15 See NED 1	
EQ 4	Opportunities for scientific investigation and recreation in wilderness setting may be significantly diminished.	Needs - Wilderness Recreation — Year — Visitor Days/Year Wilderness — 2020 — 754,800 Backcountry — 2020 — 531,200 Total — 2020 — 1,286,000
EQ 5 EQ 6	Decreasing big game winter range and migration routes threatened by urban development.	Big game winter range needs require maintaining the present area and developing the capacity to produce an additional 67,000 big game animal unit months over the future without conditions. Concurrent action is required to control development in the basin so as to permit the present and increased numbers of animals access to the winter forage.

TABLE VII-1
(Contd)

OBJECTIVES, PROBLEMS AND NEEDS

Rio Grande Basin, Colorado

NATIONAL OBJECTIVES	LOCALLY - PERCEIVED PROBLEMS	NEEDS - PROJECTED DEMANDS AND PREFERENCES NOT SATISFIED BY FUTURE WITHOUT PROJECTIONS
EQ 7	See NED 16	
EQ 8	Degradation of trout habitat due to siltation of streams by road construction and timber harvest activities.	Greater environmental concern must be exercised in designing and actual road construction on all forest lands; off-road-vehicles need to be controlled to avoid resource degradation.
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	If the endangered and threatened species are to be preserved or reintroduced in the Rio Grande Basin, much more emphasis needs to be directed toward actual implementation of positive measures to determine: existing populations of the various species; their habitat requirements; land management implications on the habitat; and reintroduction feasibility of non-resident species.
EQ 10	Smoke from sawmill burners degrades air quality.	The need is to process more than 26,000 tons (23,582 t) per year of sawmill waste into saleable products or pollution free elimination.

CHAPTER VIII

ALTERNATE PLANS

CHAPTER VIII - ALTERNATE PLANS

A. Formulation Procedures and Criteria

The USDA Procedures for Planning Water and Related Land Resources dictate that, in addition to the description of Future Without (FW) conditions presented in Chapter VI, plans are to be developed which emphasize National Economic Development (NED) on the one hand, stressing Environmental Quality (EQ) on the other hand, and develop at least one Alternate (ALT) plan showing a suitable compromise between these two "sideboard" plans.

Comparison of plans is facilitated by displaying the effects of these plans in each of the four accounts--National Economic Development, Environmental Quality, Regional Development and Social Well-Being.

A computerized accounting system along with Watershed Investigation Report information was utilized in developing information in analyzing agricultural production on possibilities shown in Tables VIII-2 and 3. The accounting system was designed to balance the use of various resources in agricultural production against their availability considering the relative cost and returns of production among the seven crops. For additional information pertaining to the development and operation of this technique in deriving the tabled information, see ESCS working document, Procedures for the Colorado Rio Grande Type IV Study ESCS-SCS Linear Programming Model by Ronald R. Rhoade and T. Niles Glasgow.

B. Alternative Plans and Effects

1. Definitions

The FW Condition is the set of alternative management strategies that best represents future conditions that will result from a continuation of ongoing state and federal programs, and private efforts.

The NED Plan is a set of alternative management strategies best able to contribute to the satisfaction of the needs related to national economic development problems identified in previous chapters.

The ALT Plan is one set of alternative management strategies designed to reasonably satisfy needs related to both NED and EQ problems.

The EQ Plan is a set of alternative management strategies best able to contribute to the satisfaction of the needs related to environmental quality problems identified in previous chapters.

2. Assumptions

Each plan above is based on its own set of assumptions. The future without assumptions were presented in Chapter VI. These assumptions are based on each agency's projections of demands for goods and services, environmental preferences and local inputs as discussed in Chapter V.

Planning analysis techniques for "State and private range and croplands" and "Federal and forest lands" activities are respectively unique. Consequently, much of the discussion including assumptions related to each plan will be segregated by these two major kinds of activities.

a. National Economic Development Plan

NED Plan criteria are designed around the effort to meet the basin's share of national demands as projected by OBERS and other sources.

(1) State and Private Range and Cropland

The NED Plan was formulated by selecting management methods and potential USDA projects that would maximize the net economic return to the basin.

Diversion Dam and Control Gate on Rio Grande

Several better management practices and 41 potential projects were identified. (See Figure VIII-1, Table VIII-1, and Appendix G.) No attempt was made to determine which projects were the "best buy" or which projects contributed most to solving the problems presented in Chapter III, since the needs identified in Chapter VII are not fulfilled even if all 41 projects were implemented.

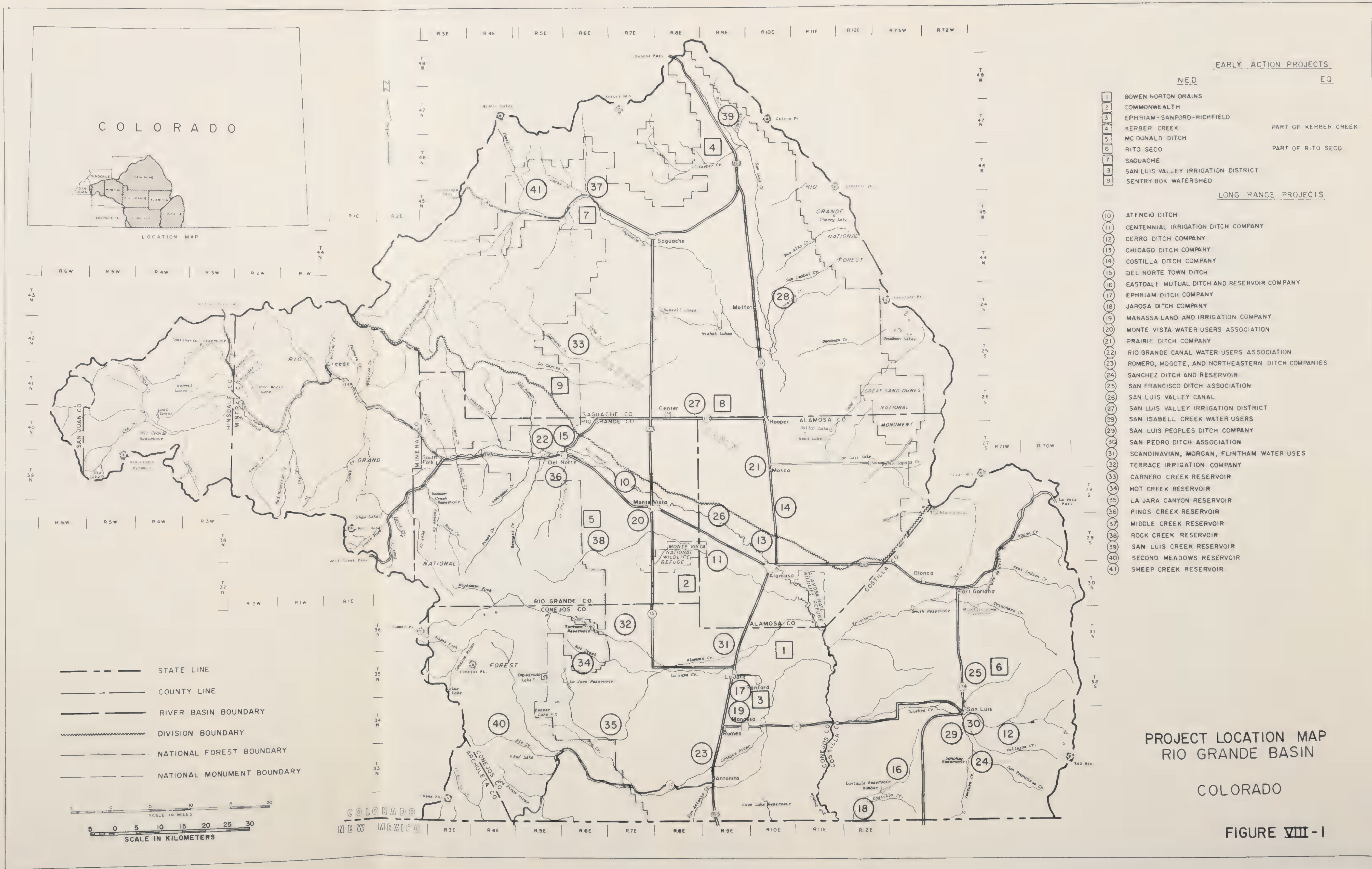
Nine projects were identified as early action projects (See Figure VIII-1) and are assumed to be implemented before the year 2000, while the remaining projects are viewed as long-range and are to be implemented later. Three projects--Trinchera Watershed, Closed Basin Division-San Luis Valley Project Colorado, and Del Norte Recreation measure--are currently in implementation and construction stages; they are included in the FW Plan.

The annual production from the NED Plan along with the several other plans is presented in Table VIII-3, while the beneficial and adverse effects of the plans are shown in Table VIII-2.

There are four early action projects dealing with flood prevention--Kerber Creek, Rito Seco, Saguache and Sentry Box--that will help maximize the net economic return to the basin. Of these, Sentry Box deals only with flood prevention to agricultural lands, Rito Seco and Saguache protect both agricultural and municipal lands, and Kerber Creek has water quality along with agricultural and municipal lands.

It was estimated that NED projects will increase the irrigation water supply to the farm by approximately 126,900 acre feet (156.5 million m^3), with an increase in efficiency of use of surface water from 29 percent to 35 percent. Increased water yield to the farm from forest lands amount to 76,000 acre feet (93.7 million m^3) for a total increase of 202,900 acre feet (250.28 million m^3) delivered to the farm.

Additional conditions of state and private range and croplands are:



COLORADO
LOCATION MAP
EARLY ACTION PROJECTS
NED
EQ
1 BOWEN NORTON DRAINS
2 COMMONWEALTH
3 EPHRIAM-SANFORD-RICHFIELD
4 KERBER CREEK
PART OF KERBER CREEK
5 MC DONALD DITCH
6 RITO SECO
PART OF RITO SECO
7 SAGUACHE
8 SAN LUIS VALLEY IRRIGATION DISTRICT
9 SENTRY BOX WATERSHED
LONG RANGE PROJECTS
10 ATENCIO DITCH
11 CENTENNIAL IRRIGATION DITCH COMPANY
12 CERRO DITCH COMPANY
13 CHICAGO DITCH COMPANY
14 COSTILLA DITCH COMPANY
15 DEL NORTE TOWN DITCH
16 EASTDALE MUTUAL DITCH AND RESERVOIR COMPANY
17 EPHRIAM DITCH COMPANY
18 JAROSA DITCH COMPANY
19 MANASSA LAND AND IRRIGATION COMPANY
20 MONTE VISTA WATER USERS ASSOCIATION
21 PRAIRIE DITCH COMPANY
22 RIO GRANDE CANAL WATER USERS ASSOCIATION
23 ROMERO, MOGOTE, AND NORTHEASTERN DITCH COMPANIES
24 SANCHEZ DITCH AND RESERVOIR
25 SAN FRANCISCO DITCH ASSOCIATION
26 SAN LUIS VALLEY CANAL
27 SAN LUIS VALLEY IRRIGATION DISTRICT
28 SAN ISABELL CREEK WATER USERS
29 SAN LUIS PEOPLES DITCH COMPANY
30 SAN PEDRO DITCH ASSOCIATION
31 SCANDINAVIAN, MORGAN, FLINTHAM WATER USES
32 TERRACE IRRIGATION COMPANY
33 CARNERO CREEK RESERVOIR
34 HOT CREEK RESERVOIR
35 LA JARA CANYON RESERVOIR
36 PINOS CREEK RESERVOIR
37 MIDDLE CREEK RESERVOIR
38 ROCK CREEK RESERVOIR
39 SAN LUIS CREEK RESERVOIR
40 SECOND MEADOWS RESERVOIR
41 SHEEP CREEK RESERVOIR
STATE LINE
COUNTY LINE
RIVER BASIN BOUNDARY
DIVISION BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL MONUMENT BOUNDARY
SCALE IN MILES
SCALE IN KILOMETERS
Saguache
Moffat
Center
Hooper
Creede
Del Norte
South Fork
Monte Vista
Mosco
Alamosa
Blanca
Fort Garland
La Jara
Sanford
Manassa
Romeo
Antonito
San Luis
SAGUACHE CO
RIO GRANDE CO
ALAMOSA CO
CONEJOS CO
COSTILLA CO
MINERAL CO
HINSDALE CO
SAN JUAN CO
ARCHULETA CO
MONTE VISTA NATIONAL WILDLIFE REFUGE
GREAT SAND DUNES NATIONAL MONUMENT
RIO GRANDE NATIONAL FOREST
COLORADO
NEW MEXICO
PROJECT LOCATION MAP
RIO GRANDE BASIN
COLORADO
FIGURE VIII-1

TABLE VIII - 1

NATIONAL ECONOMIC DEVELOPMENT PLAN PROJECTS
Rio Grande Basin, Colorado

PROJECT	MAP NO.	AFFECTED ACRES	AFFECTED HECTARES	WATERSHED	INSTALLATION COST 1/	ANNUAL COST 2/	ANNUAL BENEFITS	MAJOR FUNCTIONS
EARLY ACTION								
Bowen-Norton Drains	1	22,500	9,106	Rio Grande and Conejos River	3,831,800	261,900	357,800	Drainage needs on cropland with 4 miles (6.4 km) of drain tile needed in the Bowen drain along with 130 structures, new or replaced, also 10 (16.1 km) miles of open drains need added to both Bowen and Norton Drains.
Commonwealth	2	48,000	19,426	Rio Grande and Conejos River	476,700	32,600	61,900	Improve irrigation delivery system by installing 260 irrigation water control structures.
Ephriam-Sanford-Richfield	3	14,200	5,747	Conejos and San Antonio Rivers	703,700	48,100	164,400	Improve irrigation delivery system by combining 1.5 miles (2.4 km) of canal along with canal lining and water control structures.
Kerber Creek Watershed	4	2,400	971	Kerber Creek	2,299,400	157,200	223,100	Stabilization of critical erosion areas (mine tailings) and multi-purpose agricultural water management and flood control reservoir. Off channel multi-purpose reservoir, diversions and conduits to transport Squirrel Creek and Rawley Gulch past mine tailings, three miles (4.8 km) of channel resectioning, rip-rapping, shaping, and vegetation of mine tailing areas along Kerber Creek.
McDonald Ditch	5	1,700	688	Rio Grande	151,000	10,300	29,700	Improve irrigation delivery system by 5,300 feet (1,615 m) of concrete ditch lining on main canal, 9,200 feet (2,804 m) of concrete lateral lining, a concrete weir, a long span steel pipe flume, and new water control structures.
Rito Seco Watershed	6	300	121	Rito Seco	787,300	53,800	56,800	Provide flood protection to San Luis, Colorado and land treatment to critically eroded areas in watershed; 2.7 miles (4.3 km) long Class I dike to protect San Luis and land treatment (erosion stabilization measures) to watershed area.
Saguache Watershed	7	14,000	5,666	Saguache	4,117,500	281,500	297,200	Multi-purpose reservoir - with Agricultural Water Management and Flood Control Storage.
San Luis Valley Irrigation District	8	44,000	17,807	Rio Grande	702,000	48,000	89,400	Improve irrigation delivery system by installing 6 miles (9.7 km) of concrete canal lining, 21 water control structures and repair gates at the Rio Grande Reservoir.
Sentry Box Watershed	9	4,500	1,821	La Garita Creek	4,640,500	317,200	322,300	Multi-purpose reservoir - with agricultural water management and flood control storage.

1/1978 Price base.

2/Amortized at 6-5/8% over 100 years.

TABLE VIII - 1

NATIONAL ECONOMIC DEVELOPMENT PLAN PROJECTS
Rio Grande Basin, Colorado

PROJECT	MAP NO.	AFFECTED ACRES	AFFECTED HECTARES	WATERSHED	INSTALLATION COST 1/	ANNUAL COST 2/	ANNUAL BENEFITS	MAJOR FUNCTIONS
LONG RANGE								
Atencio Ditch	10	400	162	Rio Grande	21,400	1,500	5,500	Improve irrigation delivery system by installing six irrigation water control structures.
Centennial Irrigation Ditch Company	11	9,120	3,691	Rio Grande	461,100	31,500	122,700	Improve irrigation delivery system by installing 1.4 miles (2.3 km) of concrete lining and 46 irrigation water control structures
Cerro Ditch Company	12	2,100	850	Culebra Creek	113,000	7,700	28,700	Improve irrigation delivery system by realigning two miles (3.2 km) of canal and replacing 142 irrigation water control structures.
Chicago Ditch Company	13	4,224	1,709	Rio Grande	212,400	14,500	56,700	Improve irrigation delivery system by realigning 0.5 miles (0.8 km) of canal and 3 irrigation water control structures.
Costilla Ditch Company	14	7,240	2,930	Rio Grande	370,900	25,400	97,800	Improve irrigation delivery system by replacing 5 irrigation water control structures.
Del Norte Town Ditch	15	122	49	Rio Grande	403,000	27,600	28,800	Install 1.4 miles (2.3 km) of closed conduit to carry flood and irrigation water through Del Norte.
Eastdale Mutual Ditch and Reservoir Company	16	500	202	Culebra Creek	1,317,200	90,000	95,000	Improve irrigation delivery system by adding 13 miles (20.9 km) of underground irrigation pipelines and replace 11 irrigation water control structures.
Ephriam Ditch Company	17	1,000	405	Conejos and San Antonio Rivers	54,000	3,700	13,700	Improve irrigation delivery system by replacing 23 irrigation water control structures and lining 0.5 (0.8 km) miles of canal.
Jarosa Ditch Company	18	2,500	1,012	Costilla Creek	74,900	5,100	30,100	Improve irrigation delivery system by installing 1 mile (1.6 km) of canal lining and a new diversion structure.
Manassa Land and Irrigation Company	19	18,000	7,285	Conejos River	943,000	64,500	244,500	Improve irrigation delivery system by installing 8.5 miles (13.7 km) of concrete canal lining and 84 irrigation water control structures.
Monte Vista Water-Users Association	20	28,100	11,372	Rio Grande	1,412,800	96,600	376,600	Improve irrigation delivery system by installing 3.6 miles (5.8 km) of concrete canal lining and 10 irrigation water control structures.

1/ 1978 Price Base.

2/ Amortized at 6-5/8% over 100 years.

TABLE VIII - 1

NATIONAL ECONOMIC DEVELOPMENT PLAN PROJECTS
Rio Grande Basin, Colorado

PROJECT	MAP NO.	AFFECTED ACRES	AFFECTED HECTARES	WATERSHED	INSTALLATION COST 1/	ANNUAL COST 2/	ANNUAL BENEFITS	MAJOR FUNCTIONS
Prairie Ditch Company	21	21,100	8,539	Rio Grande	1,106,400	75,600	286,600	Improve irrigation delivery system by installing 34 miles (54.7 km) of concrete canal lining and 12 irrigation water control structures.
Rio Grande Canal Water-Users Association	22	118,000	47,755	Rio Grande	5,944,100	406,300	1,586,300	Improve irrigation delivery system by installing 5.6 miles (9 km) of concrete canal lining and 31 irrigation water control structures.
Romero, Mogote and Northeastern Ditch Companies	23	28,100	11,372	Conejos River	786,400	53,800	334,800	Improve irrigation delivery system by installing 10 miles (16.1 km) of concrete canal lining and 60 irrigation water control structures.
Sanchez Ditch and Reservoir	24	15,000	6,071	Ventura Creek	788,700	53,900	203,900	Improve irrigation delivery system by installing 34 miles (54.7 km) of concrete canal lining and 63 irrigation water control structures.
San Francisco Ditch Association	25	1,080	437	Culebra Creek	62,300	4,300	15,100	Improve irrigation delivery system by installing 2 miles (32 km) of concrete canal lining and 8 irrigation water control structures.
San Luis Valley Canal	26	35,000	14,165	Rio Grande	1,756,300	120,100	470,100	Improve irrigation delivery system by installing 21.5 miles (34.6 km) of concrete canal lining and 196 irrigation water control structures.
San Luis Valley Irrigation District	27	5,000	2,024	Rio Grande	251,200	17,200	67,200	Improve irrigation delivery system by installing 110 irrigation water control structures.
San Isabell Creek Water-Users	28	900	364	San Isabell Creek	49,800	3,400	12,400	Improve irrigation delivery system by installing 6.3 miles (10.1 km) of concrete canal lining and 13 irrigation water control structures.
San Luis Peoples Ditch Company	29	1,625	658	Culebra Creek	102,000	7,000	23,200	Improve irrigation delivery system by realignment of 12 miles (19.3 km) of canal and installing 56 irrigation water control structures.
San Pedro Ditch Association	30	1,250	506	Culebra Creek	67,000	4,600	17,100	Improve irrigation delivery system by installing 1.8 miles (2.9 km) of concrete canal lining and 39 irrigation water control structures.
Scandinavian, Morgan, Flintham Water-Users	31	8,510	3,444	Alamosa Creek	428,600	29,300	114,400	Improve irrigation delivery system by combining 2.0 miles (3.2 km) of canal along with canal lining and 14 irrigation water control structures.

1/1978 Price base.

2/Amortized at 6-5/8% over 100 years.

TABLE VIII - 1

NATIONAL ECONOMIC DEVELOPMENT PLAN PROJECTS
Rio Grande Basin, Colorado

PROJECT	MAP NO.	AFFECTED ACRES	AFFECTED HECTARES	WATERSHED	INSTALLATION COST 1/	ANNUAL COST 2/	ANNUAL BENEFITS	MAJOR FUNCTIONS
Terrace Irrigation Company	32	10,995	4,450	Alamosa Creek	562,800	38,500	148,400	Improve irrigation delivery system by installing 9 miles (14.5 km) of concrete canal lining, 10 miles (16.1 km) of underground irrigation pipeline, and 35 irrigation water control structures.
Carnero Creek Reservoir	33	300	121	Carnero Creek	6,852,300	468,400	471,400	Multi-purpose reservoir with agricultural water management and flood control storage.
Hot Creek Reservoir	34	160	65	Hot Creek	1,352,300	92,400	94,000	Multi-purpose reservoir with agricultural water management and flood control storage.
La Jara Canyon Reservoir	35	300	121	La Jara Creek	4,709,300	321,900	324,900	Multi-purpose reservoir with agricultural water management and flood control storage.
Pinos Creek Reservoir	36	700	283	Pinos Creek	4,606,000	314,900	321,900	Multi-purpose reservoir with agricultural water management and flood control storage.
Middle Creek Reservoir	37	900	364	Middle Creek	4,038,800	276,100	285,000	Multi-purpose reservoir with agricultural water management and flood control storage.
Rock Creek Reservoir	38	350	142	Rock Creek	1,875,600	128,200	131,700	Multi-purpose reservoir with agricultural water management and flood control storage.
San Luis Creek Reservoir	39	300	121	San Luis Creek	3,434,400	234,800	237,800	Multi-purpose reservoir with agricultural water management and flood control storage.
Second Meadows Reservoir	40	3,600	1,457	Elk Creek	6,836,000	467,300	503,300	Multi-purpose reservoir with agricultural water management and flood control storage.
Sheep Creek Reservoir	41	900	364	Sheep Creek	4,474,400	305,900	314,900	Multi-purpose reservoir with agricultural water management and flood control storage.

1/1978 Price Base.

2/Amortized at 6-5/8% over 100 years.

Native Pastureland with Surface
Irrigation

- All available rangeland will be used for forage production and management will be intensified from season long use with little improvements to improved-management systems to increase production; big game forage production is secondary to livestock production. Improved management systems consist of the following management practices - brush management, deferred grazing, livestock exclusion, proper grazing use, planned grazing system, wildlife upland habitat management, and firebreaks.

- Projections of sprawl development and associated wildlife consequences in the vicinity of South Fork, as described in the Future Without Plan, will occur in this plan also.

(2) Federal and Forest Land

Maximum demand for timber production was made upon the forest resources consistent with nondeclining-even flow policies on public lands and the desire for increased water yield. Other salient features of this plan are:

- In order to maximize timber production: steep slope timber harvesting will occur, planting and thinning of backlog will be accomplished; conversion of aspen seedling/sapling stands to the spruce-fir type by planting will be utilized to increase timber production.

Forestland at Platoro, Colorado

- Developed recreation needs in 2020 will be accomodated by the development of an additional 30 acres (12 ha) of Forest Service potential sites; this is four acres more than under future without conditions in 2020.

- All available rangeland will be used for forage production and management will be intensified from season long use with little improvements to improved-management systems to increase production; big game forage production is secondary to livestock production. Improved management systems consist of the following management practices-brush management, deferred grazing, livestock exclusion, proper grazing use, planned grazing system, wildlife upland habitat management, and firebreaks.

- All roadless areas containing significant amounts of timber contribute towards meeting timber demands. Three areas--Sangre de Cristo, Zapata, and Snow Mesa-Bristol Head, comprising a total of 113,347 acres (45,872 ha) and containing no significant commercial timberland--and the two current wilderness areas, will remain available for wilderness and backcountry recreation.

- Consideration for endangered and threatened species is secondary to meeting OBERS allocation.

b. Environmental Quality Plan

The EQ Plan was formulated by selecting management alternatives and potential USDA projects that would enhance and protect the environment. Plan elements include a set of alternative management strategies and resources best able to contribute to the satisfaction of needs related to environmental quality.

(1) State and Private Range and Cropland

Two potential USDA projects--Kerber Creek, Rito Seco, plus a recommendation that cost share assistance be made available for wildlife planning in corners where center pivot irrigation systems are installed--are relative to this plan.

(2) Federal and Forest Land

The Environmental Quality Plan's objective as related to federal and forest lands is to maximize total environmental quality, but still sustain the timber industry in the basin. Basic requirements behind this plan are:

- Harvest a minimum of 30 million board feet, log scale, annually to maintain the present timber industry.

- Maintain present wilderness areas and utilize all roadless areas for wilderness and backcountry recreation--a total land base of 613,500 acres (248,284 ha). Private forest land will assume a larger share of timber harvesting to permit this.

- Livestock grazing on big game winter range will be foregone so that full use of forage for wildlife is allowed.

- Migration routes will be maintained to allow freedom of movement of big game.

- Developed recreation needs will be met by the same means as outlined in the National Economic Development Plan.

- The recommendations of the recovery plan for the peregrine falcon (as finalized at some point in the future) will be fully implemented. Prairie dog towns will be maintained, to preserve habitat for the black-footed ferret. Due to maximum retention of undeveloped roadless areas, this alternative offers the most optimistic future for such endangered and threatened critters as the wolverine, gray wolf, grizzly bear, river otter, and lynx. The effect of increased harvest of private timber on the Rio Grande cutthroat trout are assumed not to be detrimental.

c. Alternate Plan

The Alternate Plan reflects one compromise which illustrates tradeoffs between economic and environmental concerns.

(1) State and Private Range and Cropland

The agricultural portion of the Alternate Plan contains the same implemented, early action and long range projects as the NED plan. In addition, however, the Alternate Plan calls for utilizing the

corners on all center pivot irrigation installations for wildlife habitat, primarily game birds. Typically, a center pivot installation in the study area is installed on a 160 acre (65 ha) plot with approximately 130 acres (53 ha) within the circular/sprinkled area and about 30 acres (12 ha) in the corner areas. Urban sprawl, while occurring, will be limited so as not to hinder big game migration.

Center Pivot Irrigation System

(2) Federal and Forest Land

Major points supporting the forestry and federal lands aspects of the Alternate Plan include:

- In addition to the two present wilderness areas and four areas assigned to wilderness study under the future without plan, two roadless areas--Bennett Peak--27,600 acres--(11,170 ha) and Pole Mountain--52,825 acres--(21,376 ha), important wildlife habitat areas--are assumed managed as wilderness or backcountry. The Weminuche and La Garita Wilderness Areas are relegated to only wilderness management while the six roadless areas are allowed wilderness or backcountry management options.

- Conditions for meeting developed recreation needs are the same as described in the National Economic Development Plan.

- Timber harvesting levels of this plan approximate volumes midway between the National Economic Development and Environmental Quality Plans. Water yield management is a part of this plan also. Planting and thinning assumptions are the same as in the National Economic Development Plan. Ability to harvest timber on steep slopes is assumed to be about one-half that assumed for the National Economic Development Plan.

- Grazing will be equivalent to National Economic Development Plan animal-unit-months on all ownerships except National Forest and BLM rangeland where a reduction is necessary to accomodate the maintenance of big game herds at current levels plus approximately a ten percent increase. Most of this increase is in the southwest portion of the basin where important elk calving areas are located in the Bennett Peak roadless area.

- No special action will be taken to reintroduce non-indigenous endangered and threatened species, but at the same time, no action will be taken to jeopardize habitat of endangered and threatened species now present in the basin.

3. Effects of Plans on Accounts

Because of the analysis systems approach undertaken in this study, the assumptions described above are mainly applicable only to determining effects on the National Economic Development and Environmental Quality Accounts. The analyses for the NED and EQ accounts have their own set of assumptions.

a. National Economic Development Account

The descriptive and tabular data provide an insight as to the effects of each plan in reference to the National Economic Development Account.

(1) State and Private Range and Cropland

Table VIII-2 presents the monetary beneficial and adverse effects of the NED, alternate and EQ plans. These effects accrue through the various early action and long range flood control and irrigation projects, forestry programs, and in the case of the EQ and alternate plans the effects of transferring center pivot irrigation corners from agriculture to wildlife habitat.

The beneficial and adverse effects of all planned actions were amortized over 100 years at 5/8% interest. Plan implementation was not assumed to materialize at one time, however. For the early action plan, a steady stream of construction cost with a corresponding O&M buildup cost was assumed between years 1978 and 2000. Transference of center pivot corners to wildlife habitat was assumed to occur in a steady stream between years 1978 and 2000. Between years 2000 and 2078 a steady O&M cost on projects and wildlife habitat cost on the center pivot corners was assumed. All of these costs were discounted to year 1978 and then amortized.

Similarly for the long range projects construction costs were assumed to occur between 2000 and 2020 with an O&M buildup during this period. A constant O&M cost was assumed between years 2020 and 2078. These also were discounted to year 1978 and amortized.

Early action beneficial effects were assumed to increase in a steady stream between years 1978 and 2000 and then maintain a constant stream to year 2078.

TABLE VIII - 2

National Economic Development Account
Rio Grande Basin, Colorado

Components	Measures of Effects (Ave. annual @ 6 5/8% plan life 100 yrs.) 1978 - 2078 Based on 1974 Costs and WRC Normalized Prices		
1. Beneficial effects			
A. The value to users outputs of goods and services	NED Plan	Alternate Plan	EQ Plan
1. Flood prevention	$ 43,500	$ 43,500	$ 23,700
2. Irrigation	1,783,400	1,759,400 1/	54,400 2/
3. Land treatment systems	65,300	65,300	65,000
4. Utilization of unemployed labor resources	97,900	97,900	31,800
5. Forest Resources	48,367,000	40,551,200	22,639,000
B. Indirect beneficial effects	184,900	184,900	11,200
Total beneficial effects	50,542,000	42,702,200	22,822,100
II. Adverse Effects			
A. Value of resource required for plan			
1. Construction	813,500	813,500	78,600
2. Engineering	109,900	109,900	10,600
3. Project administration	131,900	131,900	12,800
4. Land Rights	44,000	44,000	4,300
5. OM&R	166,900	166,900	15,100
6. Forest costs	43,991,700	36,068,000	27,847,000
B. Output loss due to land conversions		179,700	179,700
Total adverse effects	45,257,900	37,513,900	28,148,100
III. Net beneficial effects	+ 5,284,100	+ 5,188,300	- 5,326,000

1/ Reduction due to center pivot cornor loss for irrigation brought about by project action - NED plan - loss $24,000.
2/ Reduction due to center pivot corner loss on irrigation from projcet action - EQ Plan - $4,100.

Long range beneficial effects were assumed to increase in a steady stream between years 2000 to 2020 and then maintain a constant stream to year 2078. These benefits were also discounted to year 1978 and amortized.

The output loss due to land conversion comes about through the transfer of center pivot corner acreages from crop production to wildlife habitat in the EQ and alternate plans and represents this transfer on center pivot acreages without any of these three plans. Corner acreages transferred to wildlife habitat on center pivot acreages brought about by the EQ and alternate plans were treated as reductions in irrigation benefits for these respective plans.

It must be pointed out that the project beneficial and adverse effects shown in Table VIII-2 differ from those in VIII-1 in that Table VIII-2 is a plan account with assumptions made concerning construction timing as discussed above. Therefore, discounting the lag in construction is included. Table VIII-1 is based on individual projects and the project costs and benefits listed are assumed to commence upon project completion regardless of when this may occur.

Table VIII-3 presents agricultural production quantities for the National Economic Development Account. As noted, feed and malting barley are combined in the table.

(2) Federal and Forest Land

The effects of the alternative plans that are displayed in the National Economic Development Account are those which relate to the production of marketable commodities, the efficiency of that production and its effect on payments to counties from federal land. It is strongly suggested that, when utilizing any tables in this section, the relative values, within as well as among plans, are far more significant than any single value in itself.

(a) Timber Management

Timber harvest on state and private land is greatest under the NED Plan. It is most important under the EQ Plan. As timber harvest on national forest land is traded off for backcountry, wilderness, or other values,

TABLE VIII - 3

EFFECTS OF PLANS

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT
ANNUAL FOREST, RANGE, AND CROPLAND PRODUCTION VALUES

Rio Grande Basin, Colorado

SUBJECT CROP	UNIT	DECADE	OBERS E' 1/	FUTURE W/O	NED	ALT	EQ
OATS	bu (m^3)	2000	442,200 (15,583)	442,200 (15,583)	442,200 (15,583)	442,200 (15,583)	442,200 (15,583)
		2020	424,300 (14,952)	424,300 (14,952)	424,300 (14,952)	424,300 (14,952)	424,300 (14,952)
SPRING WHEAT	bu (m^3)	2000	142,200 (5,011)	67,200 (2,368)	131,000 (4,616)	142,200 (5,011)	67,200 (2,368)
		2020	136,400 (4,807)	63,100 (2,224	-	-	63,300 (2,231)
WINTER WHEAT	bu (m^3)	2000	28,000 (987)	12,000 (423)	24,600 (867)	28,000 (987)	12,000 (423)
		2020	26,900 948	10,000 (352)	-	-	10,100 (356)
BARLEY	bu (m^3)	2000	9,329,700 2/ (328,779)	9,009,300 317,479	9,835,000 (346,576)	9,835,600 (346,576)	8,247,100 (290,620)
		2020	12,584,500 2/ (443,466)	10,763,400 (379,392)	12,792,300 (450,789)	11,651,400 (410,585)	10,225,800 (360,348)
HAY-ALFALFA	tons (metric ton)	2000	214,100 (194,189)	114,100 (103,489)	162,600 (147,478)	143,800 (130,427)	114,100 (103,489)
		2020	205,400 (186,298)	95,400 (86,528)	185,000 (167,795)	185,000 (167,795)	95,400 (86,528)
SMALL GRAIN HAY	tons (metric ton)	2000	11,400 (10,340)	10,400 (9,433)	10,400 (9,433)	10,000 (9,070)	10,400 (9,433)
		2020	11,000 (9,977)	10,000 (9,070)	10,000 (9,070)	10,000 (9,070)	10,000 (9,070)
HAY GRASS	tons (metric ton)	2000	148,300 (134,508)	108,300 (98,228)	138,500 (125,620)	136,000 (123,352)	108,300 (98,228)
		2020	142,300 (129,066)	102,300 (92,786)	114,600 (103,942)	114,800 (104,124)	102,300 (92,786
POTATOES	cwt (kg)	2000	10,436,000 (473,376,960)	10,436,000 (473,376,960)	10,436,000 (473,376,960)	10,436,000 (473,376,960)	10,012,000 (454,144,320)
		2020	10,012,000 (454,144,320)	10,012,000 (454,144,320)	10,012,000 (454,144,320)	10,012,000 (454,144,320)	10,012,000 (454,144,320)
VEGETABLES	acres (hectare)	2000	6,400 (2,590)	6,400 (2,590)	6,400 (2,590)	6,400 (2,590)	6,400 (2,590)
		2020	6,400 (2,590)	6,400 (2,590)	6,400 (2,590	6,400 (2,590)	6,400 (2,590)
MINOR CROP	acres (hectare)	2000	2,100 (850)	2,100 (850)	2,100 (850)	2,100 (850)	2,100 (850)
		2020	2,100 (850)	2,100 (850)	2,100 (850)	2,100 (850)	2,100 (850)
PASTURE & RANGE	Aum	2000	2,092,600	1,676,300	1,718,900	1,710,300	1,614,800
		2020	2,504,700	1,729,800	1,744,000	1,734,700	1,640,500
Average Annual Timber Harvest	Million Board Feet Log Scale	2000	82	49.5	61.0	52.0	35.3
		2020	84	69.5	67.3	56.0	35.3
Average Annual Lumber Production (Optimal Sawing Utilization Practices)	Million Board Feet Lumber Tally	2000	121	91.6	112.9	96.2	65.3
		2020	123	128.6	124.5	103.6	65.3
Forest Stand Stocking Control	Acres Thinned Per Decade (Hectares)	2000	-----	0 (0)	3,613 (1,462)	766 (310)	0 (0)
		2020		9,516 (3,851)	10,566 (4,276	22,226 (8,995)	0 (0)
Reforestation	Acres Planted Per Decade (Hectares)	2000	-----	0 (0)	33,681 (13,631)	28,579 (11,566)	0 (0)
		2020		0 (0)	18,464 (7,472)	29,561 (11,963)	0 (0)
Average Annual Water Yield (Federal Forest Lands)	Acre-Feet (million m^3)	2000	-----	1,768,000 (2,180.8)	1,791,500 (2,209.8)	1,788,500 (2,206.1)	1,769,894 (2,183.2)
		2020		1,745,400 (2,153.0)	1,765,100 (2,177.3)	1,771,900 (2,185.6)	1,744,135 (2,151.4)

1/ Projections based on OBERS E' value of productions - See Rio Grande Headwaters, Part 13 Summary, Table 12, 1972 OBERS Projections, Regional Economic Activity in the U.S., Series E' Population Supply, Agricultural Projections, Volumes 1, 3 and 4, United States Water Resources Council, Washington, D. C., May 1975, p. 25.

2/ Represents sum of OBERS feed barly demand and Coors malting barley projection.

		2000	2020
Feed Barley	(bu)	737,400	707,500
	m^3	(25,985)	(24,932)
Malting Barley	(bu)	8,592,000	11,877,000
	m^3	(302,774)	(418,534)

industry will be increasingly dependent on timber on state and private land. Industry and individual initiative will be required to utilize federal-state assistance programs available. (See Figures H-1 through H-4, Appendix H.)

Timber yields were projected for 24 decades to assure the timber harvest for years 2000 and 2020 shown in Table VIII-3 follow sustained-yield timber management.

Table VIII-3 also includes an overview of the number of acres which need to be planted and thinned for each plan. Under the NED plan, nearly all presently nonstocked acres are reforested within five decades; this plan also has the largest number of acres requiring stocking control (thinning). The FW Plan requires stocking control on 15% fewer acres and less than half as many acres need to be planted. In both these plans most of the intensive management occurs on national forest land. Nearly as much total thinning takes place in the alternate plan as in the NED Plan, but the alternate plan calls for about three times more thinning on private land. Detailed tables are included in Appendix H.

Twenty percent more acres are planted under the alternate plan than future without conditions. Because of low timber production demands under the environmental quality plan, compared to the future without plan only 14% as many acres need to be thinned and less than 10% as many acres require planting.

From the standpoint of total board-feet of volume produced the environmental quality plan would produce only 50 percent of the future without plan in the year 2020; the alternate plan would produce 80 percent of the future without plan production while the economic development plan would almost equal the future without plan.

The values in the tables do not include any effect of a tree (genetics) improvement program because the potential has not been quantified in this region. Tree improvement programs in

other regions of the country have increased merchantable wood production by as much as 25%. Other benefits include improved plantation survival, and disease resistance. The potential benefits of a tree improvement program should be borne in mind when comparing these alternative plans.

(b) Timber Processing and Utilization

Because each plan fails to meet OBERS E' demand by maximizing timber production, analysis was directed toward increasing product output by improving utilization and sawmill efficiency. Improved utilization is meant as using not only smaller trees, but also using tops of trees down to a smaller diameter. Sawmilling efficiency involves producing more marketable products from a given piece of timber by improving the precision of the equipment, reducing saw kerf and slab waste, and making optimum cuts.

OBERS E demand for lumber (board feet lumber tally) in Table VIII-3 were derived by converting the OBERS E annual demand for board feet of sawtimber (log scale) to board feet of wood (lumber tally) under current sawing and utilization practices. Comparing these derived values to those of an improved operation, it becomes apparent that by improving sawmill processing to an optimal sawing level, total production under the NED plan for the five-decade period comes within four percent of satisfying OBERS demand. Alternate plan output meets over 80 percent of the demand, as does future without plan. Even the EQ plan would satisfy 55% of demand under the concept of optimal sawmill efficiency. Appendix H contains more details.

Viewed from another stance, upgrading processing efficiency could also permit production at present levels, but require less timber management expense by fewer acres needing management inputs. An analysis in this regard showed that by reconditioning present sawmill equipment and using smaller diameter material, as much as:

- 87% fewer acres require reforestation;
- 77% fewer acres need thinning;
- 240,000 fewer acres (76,128 ha) require forest management for timber production.

This preliminary analysis suggests the need for a more precise comparison of the benefits of spending limited federal appropriations on forest management investments versus harvesting and sawmill improvement.

(c) Sawmill Residue Management

In order to meet State air quality regulations and still dispose of sawmill residues, operators have two alternatives: either install efficient burners acceptable to meeting regulatory prescriptions or not burn at all.

If the burning alternative is pursued, it could be an economically positive or negative venture. Further research is required for each mill, but depending on the operation, energy produced could be harnassed to generate electricity or steam to run sawmill equipment such as electric motors and kilns. On the other hand, if equipment is installed purely to burn the residue efficiently in order to meet clean air standards, initial costs may be lower but, nevertheless, a cost to be borne over the life of the equipment.

If the option to not burn is chosen, three possible means of disposal present themselves: the residue can be piled to rot; bark and sawdust can be treated to produce cattle feed; or the residue can be composted for use as a soil modifier. Cooperative state-federal forest management programs, and grants from such sources as the Four Corners Regional Commission could be used for research and development of these alternatives. Local initiative is needed to bring these programs to bear on this problem.

(d) Water Yield Management

Most of the total increase in water yield as shown in Table VIII-3 is due to increased timber harvest on all commercial forest land in the basin. The Southwest portion has the

greatest potential and by managing certain public forested areas for less vegetation biomass, an increase in water yield can be attained.

Taking specific measures for increasing water yield is not a part of the future without and environmental quality plans. In the economic development and alternate plans the number of acres treated resulted in extra water yields above and beyond the yields of those same acres had they not been specifically managed to increase the yield:

	NED & ALT Plans			
Decade Midpoint	Acres Treated Per Year	(Hectares) (Per Year)	Annual Increase in water yields (acre/feet)	(m^3)
2000	-0-	-0-	5,600	6,907,600
2020	820	(332)	7,200	8,881,200

Since the additional yields are largely the result of controlling snow accumulations by manipulating timber harvesting, the effects shown above will probably be seen as increased spring streamflows. There will be little, if any, effect on the late season streamflows.

(e) Payment in Lieu of Taxes

Payment in Lieu of Taxes are a percentage of revenue collected from resource users, and vary proportionately with production of products. Disbursements of these payments to counties help offset the tax base lost due to nontaxable federal lands located within their jurisdiction. These payments are indexed using the future without plan as the basis to which the other plans are compared.

	Future Without Plan	National Economic Development Plan	Alternate Plan	Environmental Quality Plan
Payment in Lieu of Taxes Index of Trend Over 5 Decades	1.00	1.30	1.03	0.42

The trend over the five decade period from 1980 shows the NED Plan with the greatest effect, the alternate plan about the same value as future without, and the environmental quality plan less than half as economically effective to the counties.

b. Environmental Quality Account

(1) State and Private Range and Cropland

State and Private Range and Cropland, Table VIII-4 summarizes the beneficial and adverse environmental effects of the state and private range and cropland phases of the NED, ALT and EQ plans.

(2) Federal and Forest Land

The effects of the alternative plans that are displayed in the Environmental Quality Account are those which relate to non-market commodities and measures of attainment of environmental preferences. Summarized tabular data associated with the environmental quality account is found in Table VIII-5. Additional detailed explanations of this account are presented in Appendix H.

(a) Recreation Management

Recreation-type differentiation is made on the first level of either dispersed or developed. Dispersed recreation is broken out as to whether it occurs in roadless or roaded areas. If it takes place in roadless areas, nonmotorization is assumed and it will be either of a pure wilderness nature or in a less pure backcountry form. A backcountry area would offer less solitude and more development of a primitive nature, i.e., outhouses, corrals, bridges. General recreation in roaded areas is an all-inclusive term encompassing vehicular as well as the many other forms of recreation.

Other plans include the backcountry category of recreation. The EQ Plan, producing the highest number of backcountry and wilderness visitor days of all plans by utilizing all wilderness and roadless areas, satisfies 5.6% of the demand projected for the basin. Other plans have comparably lower capacities consistent with the reduction in roadless areas involved for each plan.

TABLE VIII-4
ENVIRONMENTAL QUALITY ACCOUNT

Rio Grande Basin, Colorado

	NED PLAN	ALTERNATE PLAN	EQ PLAN
Beneficial & Adverse Effects:			
A. Areas of natural beauty.	1. Projects to provide water for late season irrigation and increasing the quantity and give an additional yield of 87,700 acre-feet [108,177,950 m^3] by year 2000 and 115,200 acre-feet [142,099,200 m^3] by year 2020.	1. Projects to provide water for late season irrigation and increasing the quantity and give an additional yield of 87,700 acre-feet [108,177,950 m^3] by year 2000 and 115,200 acre-feet [142,099,200 m^3] by year 2020.	1.
	2. Projects to improve physical irrigation systems and water scheduling by year 2000 include: 4 irrigation company projects for an additional 41,100 acre-feet [50,696,850 m^3] of water, accelerated land treatment (onfarm): land leveling--2,700 acres, [1093 ha] ditch lining--96 miles; [154 km] water control structures--2,000, and irrigation water management practices. By year 2020 24 irrigation company projects for an additional 48,900 acre-feet [60,318,150 m^3] of water, accelerated land treatment (onfarm): land leveling--2,000 acres, [809 ha] ditch lining--80 miles, [129 km] water control structures--800. No center pivot corner acreages are available for conversion to wildlife habitat because of management practices.	2. Projects to improve physical irrigation systems and water scheduling by year 2000 include: 4 irrigation company projects for an additional 41,100 acre-feet [50,696,850 m^3] of water, accelerated land treatment (onfarm): land leveling--2,700 acres, [1093 ha] 96 miles, [154 km] water control structures--2,000, and irrigation water management practices. By year 2020 24 irrigation company projects for an additional 48,900 acre-feet [60,318,150 m^3] water, accelerated land treatment (onfarm): land leveling--2,000 acres, [809 ha] ditch lining--80 miles, [129 km] water control structures--800. Center pivot corner acreages are available for conversion to wildlife habitat, 10,100 acres [4,088 ha] by year 2000, and 14,600 acres [5,907 ha] by year 2020.	2. Promote plantings of wildlife habitat areas on unused portions of cropland areas, such as center pivot corner acreages to wildlife habitat. 8,600 acres [3,480 ha] by year 2,000, and 10,000 acres [4,047 ha] by year 2020.
	3. Increase forage production by promoting range, pasture, and forest management alternatives which maximize forage production and forage products on public and private lands, 1,718,900 AUMs by year 2000 and 1,744,000 AUMs by 2020.	3. Increase forage production by promoting range, pasture, and forest management by alternatives which maximize forage production and forage products on public and private lands, 1,710,300 AUMs by year 2000 and 1,734,700 AUMs by 2020.	3. Increase forage production by promoting range, pasture, and forest management by alternatives which enhance and protect the environment. Allow full use of forage by wildlife, 1,614,800 AUMs by year 2000 and 1,640,500 AUMs by 2020.

TABLE VIII-4
ENVIRONMENTAL QUALITY ACCOUNT (Cont'd)

Rio Grande Basin, Colorado

	NED PLAN	ALTERNATE PLAN	EQ PLAN
B. Quality consideration of water, land, and air resources	1. Reduce annual spring flooding by construction of structures to reduce flood damage. Multi-purpose reservoirs which have flood control as part of their purpose benefit 7,300 acres [2954 ha] and 4 communities.	1. Reduce annual spring flooding by construction of structures to reduce flood damage. Multi-purpose reservoirs which have flood control as part of their purpose benefit 7,300 acres [2954 ha] and 4 communities.	1.
	2. Improve water storage and delivery (Creede) by extending water mains, constructing storage facilities, adding new wells, adding water facilities, and establishing a strong maintenance program. Also, meet the State Water Quality Standards.	2. Improve water storage and delivery by extending water mains, constructing storage facilities, adding new wells, adding water facilities, and establishing a strong maintenance program. Also, meet the State Water Quality Standards.	2.
	3. Decrease mine and agricultural runoff with a multipurpose reservoir and ongoing land treatment programs.	3. Decrease mine and agricultural runoff with a multipurpose reservoir and ongoing land treatment programs.	3. Decrease mine and agricultural runoff by introducing programs and projects that cover the water, land, and air problems of these industries. Accelerate ongoing programs that cover water quality problems.
	4. Develop new and existing drainage of agricultural lands with drainage projects on 20,600 acres [8337 ha] and also carry out operation and maintenance programs dealing with existing systems so they may function at their maximum capacity.	4. Develop new and existing drainage of agricultural lands with drainage projects on 20,600 acres [8337 ha] and also carry out operation and maintenance programs dealing with existing systems so they may function at their maximum capacity.	4. Areas of inadequate drainage should be located and identified by wetland types. Development of suitable wetland areas into wildlife areas should be promoted, also promote wildlife areas along drainage ditches.
	5. Promote improved vegetative and management practices which reduce wind erosion damage to soils at the current rate of application.	5. Promote improved vegetative and management practices which reduce wind erosion damage to soils at the current rate of application.	5. Promote improved and accelerated management practices which reduce wind erosion and perserve the land base. Work with the research and experimental stations on new methods to control and reduce wind erosion such as improved high residue crops and tillage equipment that will leave

TABLE VIII-4
ENVIRONMENTAL QUALITY ACCOUNT (cont'd)

Rio Grande Basin, Colorado

	NED PLAN	ALTERNATE PLAN	EQ PLAN
	6. Provide water, land, and recreational facilities using safeguards to maintain water, land and air in an acceptable condition. All alternatives include the development of an additional 30 acres [12 ha] of campground to provide the needed 7,000 visitor days of developed recreation.	6. Provide water, land, and recreational facilities using safeguards to maintain water, land and air in an acceptable condition. All alternatives include the development of an additional 30 acres [12 ha] of campground to provide the needed 7,000 visitor days of developed recreation.	6. Provide water, land and recreational facilities using safeguards to maintain water, land and air in an acceptable condition. All alternatives include the development of an additional 30 acres [12 ha] of campground to provide the needed 7,000 visitor days of developed recreation.
	7. Decrease wind erosion with management practices at the current rate of application, which affects air quality in the basin.	7. Decrease wind erosion with management practices at the current rate of application, which affects air quality in the basin.	7. Decrease wind erosion with improved management practices which will improve the water and air quality in the basin.
	8. Provides for waste disposal in most economically feasible manner consistent with meeting air quality standards.	8. Advocates beneficial disposal of wastes by energy; further use of energy, crop and livestock production; attempts disposal well within air quality standards.	8. Requires that wastes be put to environmentally beneficial use either as soil modifier, cattle feed or energy production with no adverse effect on air quality; burn only would not be an option.
C. Biological resources	1. Provides for only 38% of the preferred big game forage production because livestock grazing has priority; does not assume maintenance of any migration routes.	1. Sacrifices 1% in overall livestock forage production to increase big game forage production to 46% of preferred; migration routes to selected winter range areas would be assured to maintain herds at projected level.	1. Subdivisions eliminate 5% of winter range, but still allowing 94% of preferred production; no hindrance to migration will occur; no livestock grazing is allowed on any winter range, resulting in 6% production loss.
	2. Allows for no special measures to propagate resident species or reintroduce non-resident species. Drainage of lowlands is to detriment of cranes and ducks. Limited undeveloped areas (263,000 acres) [106,436 ha] allows little habitat for wolverine, wolf, lynx and bear; funds for falcon will be less than optimal; habitat for ferret declines, but otter will be little affected; trout will benefit.	2. Results in same conditions as NED except: more remote areas (460,000 acres) [186,162 ha] are available for wolverine, wolf, bear and lynx habitat; adequate funding for falcon is available; ferret habitat is maintained; and trout habitat is adversely affected.	2. Provides best option, very little lowland habitat impacted; over 600,000 acres [242,820 ha] of remote country available for larger predatory mammals; prairie dog towns and preserve or expand necessary funds for falcon are available; generates best trout habitat.

TABLE VIII-4
ENVIRONMENTAL QUALITY ACCOUNT (Contd)

Rio Grande Basin, Colorado

	NED PLAN	ALTERNATE PLAN	EQ PLAN
D. Wilderness, primitive and natural areas	1. Demand beyond capability; 263,104 wilderness/back-country acres [106,478 ha] provide 2% of demand.	1. Demand beyond capability; 460,224 wilderness/backcountry acres [186,253 ha] provide 5% of demand.	1. Demand beyond capability, 613,529 wilderness/back-country acres [248,295 ha] provide 6% of demand. Area represents total suitable under 1973 standards.

Since dispersed recreation in roaded, general areas is highly correlated to the degree of road system development, it is reasonable to expect a higher capacity in that plan which calls for most road development in conjunction with timber management. Such is the case here, with the largest capacity occurring under the national economic development plan, the least under environmental quality, and the future without and alternate plans capacities falling between those extremes.

More than sufficient facilities for camping and picnicking are available in the basin at the present time to meet demands through 2010. An additional 26 acres (11 ha) for the future without plan and 30 acres (12 ha) for the other plans will have to be developed by 2020 to accomodate the additional 57,000 visitor days above present capacity. Efforts in this area for all plans would be concentrated on improving quality rather than increasing quantity of facilities.

(b) Big Game Winter Range and Migration Routes

The EQ Plan is capable of meeting 94 percent of the preferred big game animal-unit-months, but this is possible only because livestock grazing is forfeited in preference for big game on any winter range under this plan. The opposite is true in the national economic development plan, whereby big game forage production is secondary to domestic animal grazing; only 38 percent of the preferred number of animal-unit-months are produced--the lowest of all the plans. Future without and alternate plans provide for 42 and 46 percent of the preferred animal unit months respectively. The alternate plan curtails livestock grazing only on National Forest and BLM winter range and only to the extent necessary to maintain the Bennett Peak roadless area as an elk calving region and to approximate a ten percent increase in big game forage production.

Effective utilization of any amount of forage on winter range is dependent on the animals having unimpeded travel on the migration routes which connect seasonal ranges. If these travel routes are blocked by human habitation or activity, the elk and deer may or may not find alternative routes. If research finds that the animals will not seek other routes, local

TABLE VIII-5
Federal and Forest Lands
Effects of Plans on Environmental Quality Account
Rio Grande Basin, Colorado

Management Regime		Decade Midpoint	Plan Totals - All ownership: Future Without	Economic Development	Alternate	Environmental Quality
Recreation Capacity - Visitor days/year						
Dispersed: roadless, non-vehicular						
	Demand					
Wilderness	796,800	2020	42,418	16,500	37,500	44,900
Backcountry	531,200	2020	0	11,000	26,134	30,000
Dispersed: Roaded, general		All	1,360,000	1,436,000	1,302,000	1,192,000
Developed:		1980	1,555,402	1,555,402	1,555,402	1,555,402
		2020	1,604,932	1,612,142	1,612,142	1,612,142
Big Game Forage Production (Animal Unit Months Per Year)		All	48,696	43,899	52,794	109,180
On-Site Erosion (Tons of Soil per Year) (t)		1980	3,235,300	3,520,000	3,482,000	3,188,856
			(2,934,417)	(3,192,640)	(3,158,124)	2,892,292
		2020	2,413,300	2,378,900	2,592,700	2,057,135
			(2,188,863)	2,157,662	(2,351,579)	(1,865,871)
Reservoir Sedimentation (Acre Feet of Sediment Per Year)		1980	898,970	975,960	967,990	895,613
			(1,100)	(1,204)	1,194	(1,105)
(Million)		2020	533,540	503,640	556,770	411,589
(m^3)			(658)	(621)	(687)	(508)
Environmental Quality Indexes	Reference Value					
Water	91	1980	90	89	89	90
	91	2020	89	88	89	90
Esthetics	75	All	63	60	63	70
Wildlife	64	All	61	59	61	63
Development & Use	74	All	61	59	61	69
Total Quality	76	All	69	67	69	73

zoning or other authority can be used to protect migration routes. If the animals will seek alternative routes, local authority need only assure that all potential routes are not blocked.

(c) Erosion and Sediment

As would be expected, erosion and sediment are least in the environmental quality plan. Obvious contributory causes to increases in values of these environmental factors are timber harvesting and road construction. As a consequence, the values in Table VIII-5 bear a heavy relationship to amounts and methods of timber harvesting in the first five decades as well as other forest management practices, such as reforestation.

The initial heavy timber harvest under the national economic development plan produces more sediment and erosion during early decades, but by the 5th decade, upgrading forest roads in conjunction with this harvesting, plus heavy planting in the early decades causes erosion and sediment to decrease significantly as compared to the alternate and future without plans.

(d) Environmental Quality Indices

The Environmental Quality Indices shown in Table VIII-5 encompass a wide variety of variables. These are explained in further detail in Appendix H. No plan decreases water quality to any great magnitude, as measured by these parameters. Between future without and alternate plans, no significant changes among the indices occur. But as would be expected, the "sideboard" plans, national economic development and environmental quality, have the lowest and highest values respectively. But even by striving for "best" environmental quality in the EQ Plan, it falls short of attaining the ultimate.

c. Regional Development Account

(1) Description and Definition

The regional development account includes examination of population, sales, employment, and income effects and the level of economic activity in the basin. In addition to the overall economic impact is an analysis of what part of the economy bears the beneficial and adverse effects of an alternative plan.

(2) Assumptions

The economic analysis was developed from national industry characteristics adjusted to the specific characteristics of the region. Thus, a basic assumption of the analysis is that production processes of basin industries are not significantly different from those across the nation. One corollary to the above assumption is that worker productivity is approximately the national average.

The analysis assumes that industries will physically expand or contract proportional to increases or decreases in sales. Thus, existing firms are assumed to be operating at capacity. When any industry expands it will call for proportionally more labor of the type currently employed. No change was assumed in technology or automation throughout the planning horizon.

It is assumed that a market exists for the various forest products. The danger of excess (nonsaleable) production is controlled by demand studies previous to resource allocation in the economic development and environmental quality accounts.

The analysis is best suited to analyze "backward" linkages in the economy, these being input requirements of one industry met by the products of another. For example, sawmills require logs from the logging industry that, in turn, requires fuel from diesel wholesalers. The model is not well suited for analysis of new industry development. Thus, the structure but not size or activity of the economy in the basin is held constant.

(3) Comparative Effects of Plans

The estimates of population, gross regional product, employment, income, and sales presented in Table VIII-6 represent those amounts associated with the combined agricultural and forestry production specified in each plan. Relative tables in Appendix F contain a detailed presentation of effects by sector. That association may be direct, indirect, or induced. With respect to employment, direct effects include only those employed by the industries selling to households or exporting (e.g. sawmills). Indirect effects include those employed by supporting

TABLE VIII - 6
Combined Agriculture and Forestry Production
Effects of Plans on Regional Development Account
Rio Grande Basin Colorado

Economic Factor	Decade Midpoint	Plan (Totals - all ownerships): Future Without	Economic Development	Alternate	Environmental Quality
Sales (Millions of dollars)	2000	179.7	192.4	188.7	169.4
	2020	198.1	213.7	203.6	182.7
Gross Regional Product (Millions of dollars)	2000	140.9	150.1	147.4	132.8
	2020	156.1	167.1	159.3	143.7
Employment (Man Years)	2000	9,400	10,100	9,900	8,800
	2020	10,500	11,400	10,800	9,700
Income (Millions of dollars)	2000	73.6	78.9	77.2	69.1
	2020	82.1	88.4	83.9	75.1
Population (Numbers of people)	2000	30,300	32,500	31,900	28,300
	2020	33,800	36,800	34,800	31,300

industries (e.g. logging). Induced employment results from local expenditures by those employed directly and indirectly. Induced employment can be in any industry in the region that sells to consumers, but is often located in retail trade and services.

The relationship among plans will be nearly constant for all regional development account variables. That is, if one plan has the worst showing in sales (constant dollars), it will have the worst showing in all other variables. This will hold true for the entire plan as well as both the agriculture and forestry portions.

For all variables in the year 2000 the plans are ranked from high to low as follows: national economic development, alternate, future without and environmental quality. Within the ranking the plans are not equally distant from one another. In the case of sales, the alternate plan is $3.7 million less than the national economic development plan. The future without plan is $9.0 million less than that. In percentage terms, the alternate plan is 98%, the future without plan is 93% and the environmental plan is 88% of national economic development plan sales.

In 2020, the plans remain ranked as they were for 2000, but differences between plans change. The alternate plan is now $10.1 million less than the national economic development plan, the future without plan is $5.5 million less than the alternate plan, and the environmental quality plan is another $15.4 million less than that. In percentage terms, the alternate plan is 95%, the future without plan is 93%, and the environmental quality plan is 86% of national economic development plan sales. Thus, while the alternate and environmental quality plans maintain their respective rankings from 2000 to 2020, both show a slower rate of economic growth than the national economic development and future without plans.

The agriculture portion (see Appendix F) of the four plans is ranked as follows for the year 2000: national economic development, alternate, future without, and environmental quality. Alternate plan sales are only $1.1 million less than the national economic development plan. Future without plan

sales are $8.3 million less than the alternate plan, and the environmental quality plan is another $6.2 million less than that. On a percentage basis, the alternate plan is 99%, the future without plan is 94% and the environmental quality plan is 91% of national economic development plan sales.

In 2020 the plans again maintain their respective rankings, but vary in rates of change. The alternate plan is now $6.9 million less than the national economic development plan. The future without plan is $9.4 million less than the alternate plan, and the environmental quality plan is $5.5 million less than that. In percentage terms, the alternate plan is 96%, the future without plan is 91%, and the environmental quality plan is 88% of national economic development plan sales. Thus, all plans show a slower growth rate than the national economic development plan.

The forestry portion (see Appendix F) of the four plans for 2000 is ranked in the following manner: national economic development, alternate, future without and environmental quality. In terms of sales, the alternate plan is $2.6 million less than the national economic development plan. The future without plan is only $0.7 million less than the alternate plan, and the environmental quality plan is $4.1 million less than that. On a percentage basis, the alternate plan is 88%, the future without plan is 85%, and the environmental quality plan is 67% of national economic development plan sales.

By 2020 a major shift in plan rankings has occurred. The future without plan is first, followed in order by the national economic development, alternate, and environmental quality plans. National economic development plan sales are now $0.7 million less than the future without plan. The alternate plan is $3.2 million less than the national economic development plan, and the environmental quality plan is $6.0 less than that. On a percentage basis, the national economic development plan is 97%, the alternate plan is 86%, and the environmental quality plan is 64% of future without plan sales. All plan sales increased, but at varying rates.

In total, each plan reflects the trend set by the agriculture portion thereof. This results from the

fact that agriculture is anywhere from 4 to 11 times larger than forestry related portions of the basin economy. Within the agricultural portion malting barley production is dominant in determining the character of regional development. This is not to degrade the importance of potatoes to the basin economy, as both potatoes and barley are important crops. However, potato production is held constant over all four plans.

Examination of the tables in the Appendix and Table VIII-6 reveals that gross regional products, employment, income, and population vary in the same manner displayed by sales. In summary then, the national economic development plan is also the best regional development plan, and the environmental quality plan is the worst. The future without and alternate plans are comparable overall, but vary in their emphasis; the future without plan more strongly emphasizes the forestry portions of the economy while the alternate plan emphasizes the agriculture portion.

d. Social Well-Being Account

1. Currently Controversial Issues

The water quality planning currently in progress per section 208 of the Clean Water Act is causing concern in the ranching and farming communities. For example, the irrigation tailwater pollution problem may be solved by either tailwater collection and treatment or by changing irrigation methods to avoid creating tailwater (zero discharge). The final plan may result in the installation of expensive facilities or cause drastic changes in farm practices.

The quantity of water retained for use in the valley versus the quantity allowed to cross the state line to satisfy the water compact and how best to make up the deficit from past years' insufficient deliveries to downstream states has been the subject of much discussion. In the San Luis Valley, water is the essence of agriculture.

The national controversy over how much timber to trade off for wilderness is currently debated in the basin.

The national controversy over mineral production versus wilderness is also alive in the basin.

2. Effects of the NED Plan on Current Controversies

The planned effect of improving the efficiency of delivery and application of irrigation water is expected to have the effect of reducing the water pollution problem and the eventual impact of the final 208 water quality plan. Thus, there will be a reduction in the intensity of this issue.

The additional water yield from forest lands and improved availability from reservoir projects should help reduce the intensity of controversy of item (b).

By maximizing timber at the expense of wilderness the NED Plan will intensify this conflict. Because the roadless areas will be roaded and open to timber management, they would also be available for mineral exploration and production. Thus, this issue will also be intensified.

3. Effects of the EQ Plan on Current Controversies

The EQ Plan has practically no effect on irrigation efficiency and consequently on 208 water quality issues. Because this plan generates no additional water yield from forest land and contains only one reservoir affecting agricultural water management the intensity of controversy surrounding the water compact will increase.

By maximizing wilderness at the expense of timber and minerals, the EQ Plan will intensify these controversies.

4. Effects of the Alternate Plan on Current Controversies

The Alternate Plan will have the same effect on (a) and (b) as the NED Plan. It represents a compromise in the disposition of roadless areas. All interest groups (timber, mineral and wilderness) achieve a portion of their goal, thus, decreasing the intensity of these controversies.

5. Summary of Effects on Current Controversies

The Alternate Plan is expected to decrease the intensity of conflict over current controversies more than the other two alternatives.

Social Well-Being Account
Changes in Intensity of Current Controversies
Rio Grande Basin, Colorado

Issues	NED	ALT	EQ
208 Water Quality Planning	-	-	0
Rio Grande Compact	-	-	+
Timber vs Wilderness	+	-	+
Minerals vs Wilderness	+	-	+

Increasing intensity is indicated by a +.
Decreasing intensity is indicated by a -.
No change is indicated by a 0.

6. Potential for Inducing Conflicts

Under the NED Plan forage available for big game on winter range is expected to decrease about 10% from Future Without Plan conditions in order to maximize forage for livestock. The EQ Plan is expected to provide more than twice as much big game forage as Future Without Plan conditions by removing all livestock from winter range areas. Assuming that the forage availability is at least indicative of future big game population trends, the Guides and Outfitters would be hurt by the NED and helped by the EQ Plan. The effect of these plans on ranchers is exactly the opposite. Thus, if one group is helped, the other is hurt. This conflict may not assume unmanageable magnitude because the two groups are very closely related, i.e., many outfitters are also ranchers and nearly all are very familiar with the livestock industry. With regard to community stability, the EQ Plan would emphasize what is now a relatively small sector of the economy which should, through diversity, promote stability.

The future character of towns such as South Fork could be significantly influenced by the alternative plans. The NED Plan would increase the influence of the sawmill-logging lifestyle on the town. The character of a typical sawmilling town may not be conducive to the resort

character that would aid in taking advantage of tourism and an expanded ski area at Wolf Creek Pass. Associated changes, such as the increased truck traffic on the highway and in the woods, may not be totally compatible with recreationists driving for pleasure.

On the other hand, the EQ Plan, emphasizing clean water, clean air, wildlife and wilderness could help promote land development in the vicinity of South Fork. If not properly directed, this development could block big game migration routes and help create a conflict between local development interests and environmentalists outside the basin. The attributes of this plan would also foster the tourist industry. One disadvantage of the tourist industry is that it is seasonal. Additional seasonal employment would not be as beneficial to community stability and cohesiveness as the full time employment associated with the expansion of the timber industry under the NED Plan.

The EQ Plan would also reduce mineral production potential on 600,000 acres (242,820 ha) of wilderness and backcountry. Wilderness status does not prevent mineral production but would increase the cost of development. This would intensify the conflict between environmentalists and the mineral industry.

The NED Plan would result in considerably more total employment than the EQ Plan. (Table VIII-7 and Table F-6, Appendix F allows comparisons by type of job at two points in the future.) The additional opportunities combined with the manpower training programs already functioning in the basin should make it possible for a greater percentage of young people to stay in the valley without sacrificing career opportunities and income. The exodus of the young people from the valley could thus be stemmed.

C. Correlation of Plans to Objectives and Problems

While the previous discussion bares assumptions and procedures of alternative plans and their effects upon four accounts as prescribed by Principles and Standards, many original objectives and problems are not fully addressed, if at all. It is omission by intent in that many issues are purely qualitative in nature, whereas most considerations thus far have centered around quantified analysis. By correlating plans back to problems and objectives, a clearer perspective of their effectiveness and focus can be gained.

TABLE VIII-7

Social Well-Being Account

Rio Grande Basin, Colorado

		NED Plan	Alternative Plan	EQ Plan
A. Net Employment Effects 1/ 2/				
	2020	1. 417 additional jobs added above FW.	1. 284 additional jobs added above FW.	1. 371 less jobs than FW.
		2. 71 for women above FW.	2. 53 for women above FW.	2. 63 women less than FW.
		3. 166 for minorities above FW.	3. 106 for minorities above FW.	3. 144 minorities less than FW.
		4. 212 seasonal above FW.	4. 190 seasonal above FW.	4. 149 part-time less than FW.
	2020	1. 469 additional jobs added above FW.	1. 107 additional jobs added above FW.	1. 595 less jobs than FW.
		2. 87 are for women above FW.	2. 24 are for women above FW.	2. 98 less women than FW.
		3. 183 are for minorities above FW.	3. 31 are for minorities above FW.	3. 247 minorities less than FW.
		4. 409 are seasonal above FW.	4. 212 are for seasonal above FW.	4. 126 seasonal less than FW.
B. Recreational Opportunity Effects				
		1. Provide picnic facilities at Del Norte.	1. Same as NED #1.	1. Same as NED #1.
		2. 30 more acres (12 ha) of National Forest Recreational sites (four more than FW).	2. Same as NED #2.	2. Same as NED #2.
		3. Imoroved fishing on Kerber, Rito Seco, Saguache and La Garita Creeks.	3. Same as NED #3.	3. Improved fishing on Rito Seco & Kerber Creeks.
		4. Big game animal units at 38% of the preferred planned level compared to 42% for FW.	4. Approximately 10,000 acres (4,047 ha) by 2000 and 14,400 acres (5,909 ha) by 2020 of game bird hunting in center pivot irrigation corners retained for wildlife.	4. Approximately 8,600 acres (3,480 ha) by 2000 and 10,000 acres (4,047 ha) by 2020 of game bird hunting in center pivot irrigation corners is retained for wildlife.
		5. Provide 16,500 visitor days of wilderness recreation compared to about 42,400 FW and 11,500 visitor days of backcountry recreation compared to none FW by 2020.	5. Big game animal at 46% of the preferred planned level.	5. Big game animal units at 95% of the preferred planned level.
			6. Provide 37,500 visitor days wilderness recreation and about 26,100 visitor days of backcountry recreation by 2020.	6. Provides 44,900 visitor days of wilderness recreation and 30,000 visitor days of backcountry recreation by 2020.
C. Effects on Life, Health and Safety				
		1. Protection of life, health, safety and property through flood protection on Rito Seco, Kerber, Saguache and La Garita Creeks.	(Same as NED Plan)	1. Protection of life, health, safety and property through flood protection on Rito Seco and Kerber Creeks.
		2. Improved water quality with a resulting improvement of health and safety on Kerber and Rito Seco Creeks.		2. Same as NED #2.

1/ The number of jobs added is relative to the without plan (FW), therefore, the relationship between 2000 and 2020 as well as total employment versus minorities, women and seasonal is indirect.

2/ Women, minorities and seasonal employment is not additive due to duplication.

TABLE VIII- 8
OBJECTIVES, PROBLEMS AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

National Objectives	Local Problems	Effectiveness of Alternative Plans: National Economic Development	Alternate	Environmental Quality
NED 1	Inadequate water for late season irrigation	Increased total available irrigation water at the farm, which includes project and forest water yield. (see monthly breakdown below)	Same as NED	Provides for 2,000 acre-feet [2,467,000 m³] of water for late season irrigation.
NED 2	Overappropriation of streamflow and withdrawals for Rio Grande Compact.	By increasing water yield, alleviates some overappropriation and compact issues, but does nothing towards solution.	Same as NED	No significant effect.
NED 3	Inefficient irrigation and delivery system	Provides for: Leveling 4,700 acres land, [1,902 ha] Lining 176 miles [283 km] of ditch, installing 2,800 control structures.	Same as NED	Includes limited diversion canals and irrigation water control.
NED 4	Inadequate drainage	Sum of all potential projects would drain 20,600 acres, [8,337 ha].	Same as NED	No effect.
NED 5	Flooding	All projects would provide control for 4 communities and 7,300 acres, [2,954 ha].	Same as NED	Provides flood control for 1 community and 2,000 acres, [809 ha].
NED 6	Low inherent fertility and organic matter	Provide technical assistance to owners/operators for upgrading their soils.	Same as NED	Same as NED
NED 7 EQ 1	Wind erosion	Promote management practices which have surface residues, establish windbreaks and maintain soil cover.	Same as NED	Same as NED
NED 8	Noxious weed control	Suggests establishing noxious plant & weed management districts to effectuate control without degrading environment.	Same as NED	Same as NED, but would limit control to non-wildlife habitat areas.
NED 9	Limited range of crops	Intensifies research to broaden range of crops adaptable to basin.	Same as NED	Same as NED as long as wildlife and nature plant patterns are not disrupted.
NED 10	Inadequate rural electrification	Provides for no new source of electric energy; advocates cooperation among responsible agencies for expeditious rural service to handle irrigation and housing needs.	Same as NED	Same as NED, except that all service facilities must be compatible with environment

NED 1 — National Economic Development:

Month	Acre-feet	Million (m^3)
April	7,300	9.0
May	65,100	80.3
June	66,600	82.2
July	28,600	35.3
August	21,400	26.4
September	13,900	17.1
Total	202,900	250.3

TABLE VIII- 8
OBJECTIVES, PROBLEMS AND ALTERNATIVE PLANS (Contd)

Rio Grande Basin, Colorado

National Objectives	Local Problems	Effectiveness of Alternative Plans: National Economic Development	Effectiveness of Alternative Plans: Alternate	Effectiveness of Alternative Plans: Environmental Quality
NED 11	Underdeveloped range resources and overgrazing	Does not meet demand projections; capability of meeting demand is: Year — % of Demand 1990 — 82 2020 — 70	Same as NED, but capability of meeting demand is: Year — % of Demand 1990 — 81 2020 — 69	Same as NED, but capability of meeting demand is: Year — % of Demand 1990 — 76 2020 — 66
NED 12	Inadequate sanitation	Advocates implementing completed sanitation plan for San Luis Valley.	Same as NED	Same as NED
NED 13	Inadequate municipal water supply	Considers extending water mains, constructing storage facilities, adding new wells and intake facilities.	Same as NED	Same as NED, plus must meet State Water Quality Standards.
NED 14	Poor housing	Backs strong initiative for promoting low cost housing by local governmental elements with assistance from state and federal agencies.	Same as NED	Same as NED
NED 15 EQ 2	Lack of recreational areas and facilities	Demands through year 2020 can be met by developing 30 additional acres (12 ha) of potential sites.	Same as NED	Same as NED
NED 16 EQ 7	Inadequate access to public lands for recreational, hunting, and fishing.	Would provide greater access in conjunction with increased timber management activities.	Because of less timber management activity, less access will be provided.	Advocates minimum access system consistency with use; little access provided through timber management.
NED 17	Insufficient timber supply to operate existing mills at capacity. Current level of timber management will not allow basin's resources to contribute their share of nation's future needs. Significant mortality in over mature; significant stagnation in immature stands.	Demands are beyond capability: Year — Capability as % of Demand 1980 — 85 1990 — 71 2000 — 74 2010 — 73 2020 — 80 For 5 decades 77 Timber supply is more than adequate to operate mills at capabity on a one-shift basis; losses to mortality would decrease as harvesting increases; stand release operations to maintain productivity would eliminate stagnation.	Demands are beyond capability: Year — Capability as % of Demand 1980 — 70 1990 — 64 2000 — 63 2010 — 65 2020 — 67 For 5 decades 66 Supply midway between current subsistency level and maximum; little loss to mortality and little stagnation because of relatively high production schedule.	Demands are beyond capability: Year — Capability as % of Demand 1980 — 50 1990 — 43 2000 — 43 2010 — 42 2020 — 42 For 5 decades 44 Supply only sufficient to operate mills at current levels; increases in losses due to mortality and further stagnation is to be expected.
NED 18	Fluctuating utilization of recreation resources	Plan itself has no effect; degree of fluctuation will subside as society moves more toward flexible daily work schedules, staggered vacation periods, longer weekends, etc.	Same as NED	Same as NED

TABLE VIII-8
OBJECTIVES, PROBLEMS AND ALTERNATIVE PLANS (Cont'd)

Rio Grande Basin, Colorado

NATIONAL Objectives	Local Problems	Effectiveness of Alternative Plans: National Economic Development	Alternate	Environmental Quality
EQ 1	See NED 7			
EQ 2	See NED 15			
EQ 3	Water pollution from mine drainage and agricultural runoff.	Includes EQ projects; therefore would be as or more effective.	Same as NED	Provides for curtailing pollution from these sources in Kerber Creek and Rito Seco Watershed.
EQ 4	Opportunities for scientific investigation and recreation in wilderness setting may be significantly diminished.	Demand beyond capability; 263,104 wilderness/back-country acres [106,478 ha] provide 2% of demand.	Demand beyond capability: 260,224 wilderness/back-country acres [186,253 ha] provide 5% of demand.	Demand beyond capability: 613,529 wilderness/back-country acres [248,295] provide 6% of demand. Area represents total suitable under 1973 standards.
EQ 5	Decreasing big game winter range and migration routes threatened by urban development.	Provides for only 38% of the preferred big game forage production because livestock grazing has priority; does not assure maintenance of any migration routes.	Sacrifices 1% in overall livestock forage production to increase big game forage production to 46% of preferred; migration routes to selected winter range areas would be assured to maintain herds at projected level.	Subdivisions eliminate 5% of winter range, but still allowing 94% of preferred production; no hindrance to migration will occur; no livestock grazing is allowed on any winter range, resulting in 6% of production loss.
EQ 7	See NED 16			
EQ 8	Degradation of trout habitat due to siltation of streams by road construction and timber harvest activities.	Creates little more erosion and sediment (3%) than EQ 5-decade period because of heavy reforestation and rapid upgrading of forest roads.	Produces most erosion and sediment - 14% more than EQ in 5 - decade period; reforestation and roads improvement are not accomplsihed as quickly as NED.	Embraces most favorable conditions because of least road construction and timber harvesting.
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	Allows for no special measures to propagate resident species or reintroduce non-resident species. Drainage of lowlands is to detriment of cranes and ducks. Limited undeveloped areas (263,000 acres) [106,436 ha] allows little habitat for wolverine, wolf, lynx and bear; funds for falcon will be less than optimal; habitat for ferret declines, but otter wil be little affected; trout will benefit.	Results in same conditions as NED except: more remote areas (460,000 acres) [186,162 ha] are available for wolverine, wolf bear and lynx habitat; adequate funding for falcon is available; ferret habitat is maintained; and trout habitat is adversely affected.	Provides best option; very little lowland habitat impacted; over 600,000 acres [242,820 ha] of remote country available for larger predatory mammals; prairie dog towns are preserved or expanded, necessary funds for falcon are available, generates best trout habitat.
EQ 10	Smoke from sawmill burners degrades air.	Provides for waste disposal in most economically feasible manner consistent with meeting air quality standards.	Advocates beneficial disposal of wastes by further use in energy, crop and livestock production; attempts disposal well within air quality standards.	Requires that wastes be put to environmentally beneficial use either as soil modifier, cattle feed or energy production with no adverse effect on air quality; burn only would no be an option.

CHAPTER IX

OPPORTUNITIES FOR USDA PROGRAMS IN THE ALTERNATE PLAN-DEVELOPMENT AND IMPACT

CHAPTER IX - OPPORTUNITIES FOR USDA PROGRAMS IN THE ALTERNATE PLAN, DEVELOPMENT AND IMPACT

Opportunities for solving identified problems and for meeting anticipated needs through USDA programs are presented in this chapter (See Appendix I). The initiative required for using USDA program resources generally rests with the residents and landowners in the basin. Land treatment measures such as land leveling, ditch lining, drainage field ditches, and structures for water control will be accomplished only when the individual landowner is motivated to do so. Other measures such as multipurpose structures, canal lining, drainage systems, and canal structures require group or community action. Land treatment measures, when combined with a structural program, provide an integrated watershed management program. There is a continuing program to inform landowners of the assistance available from USDA agencies in order that they may select the combination of action programs that best meet their needs and desires.

A. USDA Programs to Implement the Alternate Plan

1. PL 74-46

Land treatment is a continuing need. The USDA, through the Soil Conservation Service, Agricultural Stabilization and Conservation Service, and the Farmers Home Administration, provides technical and financial assistance to landowners and operators for the planning and application of land treatment measures. The potential projects which could possibly be undertaken under an accelerated Public Law 46 program or GPCP include: land leveling, 4,700 acres (1,902 ha); ditch lining, 176 miles (283 km); water control structures, 2,800; and irrigation water management practices. Also conversion of center pivot corner acreages to wildlife habitat--24,700 acres (9,996 ha) are available.

2. PL 83-566

The potential USDA projects which could possibly be undertaken under Public Law 566 include projects listed in Chapter VIII Tables VIII-2 and VIII-3 are as follows: Kerber Creek, Rito Seco, Saguache, Sentry Box, Centennial Irrigation Ditch Company, Cerro Ditch Company, Chicago Ditch Company, Costilla Ditch Company, Jarosa, San Luis Valley Canal, San Luis Peoples Ditch, Scandinavian-Morgan-Flintham Water Users, Terrace Irrigation Company, Carnero Creek, Hot Creek, La Jara Canyon, Pinos Creek, Middle Creek, Rock Creek, San Luis Creek, Second Meadows and Sheep Creek.

The project structural measures include 12 reservoirs, one floodway, and 9 canal lining systems with needed structures. The estimated installation cost of these projects is $54,105,800.

3. PL 83-703 - RC&D

The potential USDA projects which could possibly be undertaken as RC&D projects include the following: Bowen and Norton Drains; Commonwealth; Ephriam, Sanford, Richfield; McDonald Ditch; San Luis Valley Irrigation District; Atencio Ditch; Del Norte Town Ditch; Eastdale Mutual Ditch; Ephriam Ditch; Manassa Land and Irrigation Co.; Monte Vista Water Users; Prairie Ditch Co.; Rio Grande Canal Water Users; Romero, Magote, and Northwestern; Sanchez Ditch and Reservoir; San Francisco Ditch Association; San Luis Valley Irrigation District; San Isabell Creek Water Users; and San Pedro Ditch Association.

The project structural measures include 19 canal lining systems with needed structures and one drainage system. The estimated installation cost of these projects is $19,072,500.

4. Cooperative Federal-State-Private Forestry Programs

Existing cooperative forestry programs can be accelerated or initiated to help meet needs and solve problems on nonfederal public lands and private forest lands. These programs provide a variety of forestry projects and measures for development and protection of these forest lands. The programs are applied under the direction of the State Foresters. The state agencies, private forest owners, processors, rural community planners, developers, and the Forest Service cooperate to implement the programs.

5. National Forest Programs

There are many opportunities for accelerated development to meet projected needs and solve problems on the National Forest lands.

Land treatment measures are important features of the National Forest program. Area treatment may consist of establishing range grasses, plant control, fertilizing, tree planting, timber stand improvement, sloping and revegetating roadbanks, fencing, range water developments, control of grazing, improvement of transportation facilities, wildlife and fish habitat improvements, and many other activities. These measures will provide protective cover for the critical areas, increase the infiltration and percolation rates of the soil, reduce the rate of erosion, the production of sediment, and stabilize the rate of runoff. They will also contribute to satisfaction of the growing demands for forestry related goods and services.

6. Rural Electrification Administration

The USDA - Rural Electrification Administration (REA) administers two loan programs for (1) rural electrification systems and power generating facilities and (2) extension and improvement of rural telephone service. Loans for rural electrification are made to cooperatives, public utility districts, municipalities, and power companies to finance generating, transmission, and distribution systems for providing electricity to rural areas without central station electric service.

Local units of government need to continue to work with the local electric power supply companies to improve inadequate rural electrification to increase the supply of electric energy by increasing the number of high voltage electrical lines serving the basin.

Creede-Water Supply Pipeline

7. Farmers Home Administration Loans

Farmers Home Administration (FmHA) furnishes farm credit for family-type farms and rural area projects. Farm ownership, farm operating, farm housing, water development and soil conservation-type loans are all available to local landowners and operators. Watershed loans are available to assist eligible organizations in meeting their share of cost of works of improvement in connection with PL-566 watershed protection projects and RC&D projects. Loans are available to install new or improve existing water and sewage treatment facilities in urban and rural communities.

B. Impacts of USDA Programs

Implementation of the Alternate Plan through USDA programs will have the following impacts:

1. Environmental Impacts

Water quality in the Rio Grande will improve as erosion and sedimentation is reduced on 2,920,800 ac (1,182,000 ha) of range. Late season irrigation water and improved delivery systems on 443,500 acres (177,400 ha) in 41 project areas will improve the visual aspects of cropland during late summer months by providing a green growing cover. Dust in the air will be reduced as improved vegetation and management practices reduce wind erosion. The natural beauty of the area will be improved as the air and water qualities are improved. Wildlife planting in corners at center pivot irrigated fields will provide 10,100 acres (4,088 ha) of new wildlife habitat. Management programs on 2,366,200 acres (946,500 ha) of public lands will provide increased protection of threatened and endangered species. These programs will also improve wildlife and fishery habitat.

2. Adverse Environmental Impacts Which Cannot Be Avoided

Installation of 12 multipurpose reservoirs, 166 miles (267 km) of concrete ditch lining and 14 miles (23 km) of drains will change wildlife habitats. The losses of habitat values will be mitigated to the extent feasible. Land use in the reservoir areas will change from pasture and wildlife lands to water area when dams are built. Since the purpose of these projects is to improve existing systems, there will not be a change in land use in the benefitted areas.

Temporary increase in sedimentation due to construction activities will occur.

3. Alternatives

Alternatives to the Alternate Plan are many and varied. Chapter VIII describes two additional plans, NED Plan and EQ Plan, either of which could be implemented with USDA programs. Other alternatives include implementing only parts of each plan as well as doing nothing.

4. Short-Term Uses Versus Long-Term Productivity

The designation of two roadless areas will reduce the timber harvesting in 80,425 acres (32,550 ha). By developing projects to provide 87,700 acre feet (108,177,950 m^3) by year 2020 of late season irrigation water, and to improve irrigation water delivery system the long-term productivity of 443,500 acres (177,400 ha) cropland will be increased. Management of forest lands will provide for timber production which, in turn, will convert 29,560 acres (11,960 ha) of forest lands into pasture for a short time.

5. Commitment of Resources

The land on which reservoirs will be constructed will be committed to that use. Energy, technology, and raw materials used in project installation will be irretrievable during the life of the projects.

C. Correlation of Local Problems to USDA Programs

Table IX-1 gives a correlation of the local problems in relation to existing and potential USDA programs to solve these problems.

TABLE IX-1

CORRELATION OF LOCAL PROBLEMS TO
USDA PROGRAMS

Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEM (PUBLIC CONCERNS)	USDA PROGRAMS
NED 1	Irrigation water for late season irrigation.	PL 83-566 - Watersheds PL 74-46 - Agricultural Conservation Program (ACP) PL 84-1021 - Great Plains Conservation Program (GPCP) PL 87-703 - Resource Conservation & Development Program (RC&D)
NED 2	Over appropriation of streamflow. Withdrawals for Rio Grande Compact.	None Available.
NED 3	Inefficient irrigation. Inefficient delivery system.	PL 83-566 - Watersheds PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D
NED 4	Inadequate drainage.	PL 83-566 - Watersheds PL 74-46 - ACP PL 87-703 - RC&D
NED 5	Flooding.	PL 83-566 - Watersheds Flood Hazard Analyses PL 87-703 - RC&D
NED 6	Low inherent fertility and organic matter.	PL 74-46 - ACP PL 84-1021 - GPCP Cooperative Forest Management Act of 1950
NED 7	Wind erosion.	PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D (Urban Development)
NED 8	Noxious weed control.	Science and Education Administration - Federal Research PL 74-46 - ACP PL 84-1021 - GPCP Administration of National Forest Land
NED 9	Limited range of crops.	Science and Education Administration - Federal Research SCS-Plant Materials
NED 10	Inadequate rural electrification.	Rural Electrification Administration (REA)
NED 11	Underdeveloped range resources. Overgrazing.	Administration of National Forest Land PL 74-46 - ACP
NED 12	Inadequate sanitation.	Farmers Home Administration (FmHA)
NED 13	Inadequate municipal water supply (Creede).	(FmHA) PL 83-566 PL 87-703 - RC&D

TABLE IX-I

CORRELATION OF LOCAL PROBLEMS TO
USDA PROGRAMS

Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEM (PUBLIC CONCERNS)	USDA PROGRAMS
NED 15 EQ 2	Lack of recreational areas and facilities.	Administration of National Forest Land PL 87-703 RC&D PL 83-566
NED 16	Inadequate recreational access.	PL 87-703 RC&D
NED 17	Insufficient timber supply to operate existing mills at capacity. Current level of timber management will not allow basin's resources to contribute their share of nation's future needs. Significant mortality in overmature timber stands. Significant stagnation in immature stands.	Administration of National Forest Land Cooperative Programs on State & Private Lands Clarke-McNary Act of 1924 Soil Conservation & Domestic Act of 1936 Pest Control Act of 1947 Cooperative Forest Management Act of 1950 Agriculture Act of 1956 Rural Development Act of 1972
NED 18	Fluctuating under and over utilization of recreation resources.	None.
EQ 1	Wind erosion.	PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D (Urban Development)
EQ 3	Water pollution is being caused by mine drainage and agriculture runoff.	PL 83-566 - Watershed PL 74-46 - ACP PL 84-1021 - GPCP PL 87-703 - RC&D Administration of National Forest Land
EQ 4	Opportunities for scientific investigation and recreation in a wilderness setting may be significantly diminished.	Administration of National Forest Land
EQ 5	Decreasing big game winter range	Administration of National Forest Land
EQ 6	Big game migration routes are threatened by urban development.	None.
EQ 7	Inadequate access to public land for hunting and fishing purposes.	Administration of National Forest Land
EQ 8	Degradation of trout habitat due to silitation of streams by road construction & timber harvest activities.	Administration of National Forest Land
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	Administration of Nation Forest Land
EQ 10	Smoke from sawmill burners degrades air quality.	Cooperative Forest Management Act of 1950 PL 87-703 RC&D

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

CHAPTER X - COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Productive use and future development of the physical, biological, social, and economic resources of the basin are important responsibilities of local people. Wise and careful management can enhance and perpetuate the quality and usefulness of the environment, but many efforts including research, education, and land use planning are needed. There are many federal, state, community, and private programs available that are applicable to specific segments of conservation planning and implementation (see Appendix I). In many instances, there is duplication of effort, overlapping of purpose and scope, and agency rivalry in the application of these programs. Alternative levels of development exist not only in the physical and economic potentials but also in the choice of programs that will best solve the problems and satisfy the needs. To more effectively extend the services of available federal and state agency programs, USDA Committees for Rural Development have been formed. These committees assist rural communities, groups, and individuals to locate and secure the needed service programs. Evaluation of alternative programs, when a choice is available, is up to the local people.

If land and water resource problems are recognized and advance planning is completed in time, the USDA will have the necessary programs available when farm operators need assistance in developing the new irrigated cropland projected for the basin. All of the existing programs (listed in a previous chapter of this report) will be needed in developing the resources. One of the largest needs will be for a loan program to finance needed conservation practices, land development, and irrigation facilities for new and old irrigated areas. The Farmers Home Administration loan programs can do a part of this, but the ever expanding capital needs of agriculture create a need for new capital sources. The Soil Conservation Service, working through local soil conservation districts, will provide technical assistance in farm and ranch planning, soil surveys, structural program investigations, and for installing conservation practices. The Agricultural Stabilization and Conservation Service will need to provide an expanded program of cost sharing (through ACP) for conservation practices that are deemed to be of public benefit. The Science and Education Administration-Extension, through the local county agents, will need an expanded program of adult education and leadership training, particularly for the new operators who move into the basin and are unfamiliar with local farming methods and climatic problems.

Program coordination between all of the concerned federal, state and local agencies is necessary to assure that the proposed land and water resource development projects complement each other, and provide for a coordinated development of the resources and economy of the basin.

The opportunity for federal assistance to obtain greater returns from the resource base was presented in Chapter I, opportunities utilized. This may be partially due to (1) lack of knowledge or interest in the programs, and (2) fiscal or legislative limitations inherent in the existing programs. If resource utilization is to improve, the people will need to accept and support the concept of resource management. Initial acceptance must be with each individual; and ultimate support must be through group action, either by political subdivisions or private organizations. Group participation is essential for implementation by permitting democratic decision on those features of the improvement program that affect or serve more than the individual.

Information and education services offered by various state and federal agencies cover a rather broad spectrum of interests. They range from conservation practices through home economics to agricultural production economics. Regardless of area interest, they are aimed at improving the conditions existing in the basin's farm or in rural areas. Program and information services of various state and federal agencies should be improved and intensified in order to bring the conservation message to a greater number of people in a manner that provokes interest and stimulates activity.

An excellent example of this type activity is the nationally known *Smoky Bear Fire Prevention Compaign.* Professionally administered, this advertising program has probably done more to reduce the rate of wildfire damage than any other Forest Service program.

Another good example is the Soil Stewardship Program, sponsored by the National Association of Soil and Water Conservation Districts, which promotes responsible stewardship of the nation's soil and water resources through local church programs.

Eventually, the effective development and management of water and related land resources will require a consolidated approach through group planning and application of solutions. Existing laws, which permit cities, towns, and special benefit districts to enter the field of resource development and management, stress local initiation of their application. The implementation of the proposals of this report, which are designed to improve living conditions for the residents, rests largely with those residents. State and federal agencies can provide consultative and technical services, but these alone cannot and will not accomplish the efficient use of resources without community and group initiated action. Local individual leadership needs to be stimulated and their influence used to promote conservation.

County land and water regulatory organizations are needed. County Planning and Zoning Commissions established under law and working with state and federal agencies, could plan for efficient and optimum use of water and related land. These commissions along with the soil conservation districts should have the legal authority to negotiate land

easements, contract for services, levy taxes, and make zoning decisions to provide for the beneficial use of the resources while protecting public and private investment.

Abandoned Ranch Buildings Southwest of Monte Vista, Colorado

The U. S. Department of Housing and Urban Development currently sponsors a joint venture between the federal government and the private insurance industry whereby qualifying residential and business properties existing in flood hazard areas will be eligible for flood insurance at reduced rates. New properties would have to pay the unadjusted premiums. This program will be effective only if local or state organizations take the proper steps to provide zoning that will reduce or prevent future flood damages.

Land use planning expertise is needed to provide highway designers and urban developers with physical information which will enable them to provide adequate safeguards to the basin's fragile water and land resources. The Soil Conservation Service can provide soils data

Rio Grande near South Fork, Colorado

pertaining to the physical suitability of soils for road or house building, construction of sanitary disposal systems, drainage characteristics, and other information about the capabilities of the soils for nonagricultural use. Specific legislation or ordinances requiring soil suitability surveys to be made would insure more satisfactory developments.

Identification of these areas and the evolution of coordinated development plans, both within them and along their fringes, will insure against misuse and/or extensive and expensive rehabilitation by future generations.

In this age of natural landscape use and modification, the task is one of achieving balanced development between intrinsic and extrinsic values. The objective in rural areas should be the identification, preservation, and protection of the most outstanding natural values and insuring that man-made values, once introduced, are developed in harmony with the environment.

Table X-1 gives a correlation of the local problems in relation to existing or potential state and federal agencies (non-USDA) that are available to solve these problems.

TABLE X-1

CORRELATION OF LOCAL PROBLEMS TO
NON-USDA PROGRAMS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	NON-USDA PROGRAMS
NED 1	Inadequate water for late season irrigation.	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Resources
NED 2	Over appropriation of streamflow. Withdrawals for Rio Grande Compact.	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Division of Water Resources Four Corners Regional Commission
NED 3	Inefficient irrigation. Inefficient delivery system.	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Resources Bureau of Land Management Extension Service
NED 4	Inadequate drainage.	Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Board of Land Commissioners Colorado Division of Water Resources Soil Conservation Districts Four Corners Regional Commission Corps of Engineers
NED 5	Flooding.	Corps of Engineers Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Resources Colorado Department of Local Affairs
NED 6	Low inherent fertility and organic matter.	Bureau of Land Management Colorado State Board of Land Commissioners Coil Conservation Districts Extension Service

TABLE X-1

CORRELATION OF LOCAL PROBLEMS TO
NON-USDA PROGRAMS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	NON-USDA PROGRAMS
NED 7	Wind Erosion.	Colorado State Forest Service Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Parks and Outdoor Recreation Colorado State Board of Land Commissioners Soil Conservation Districts Colorado Divisio of Wildlife Extension Service
NED 8	Noxious weed control.	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado State Board of Land Commissioners Colorado Division of Wildlife Soil Conservation Districts Four Corners Regional Commission Extension Service
NED 9	Limited range of crops.	Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Soil Conservation Districts Extension Service
NED 10	Inadequate rural electrification.	Bureau of Reclamation Corps of Engineers Colorado Department of Local Affairs Four Corners Regional Commission
NED 11	Underdeveloped range resources. Overgrazing.	Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Soil Conservation District Extension Service

TABLE X-1

CORRELATION OF LOCAL PROBLEMS TO
NON-USDA PROGRAMS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	NON-USDA PROGRAMS
NED 12	Inadequate sanitation.	Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Division of Local Affairs Four Corners Regional Commission
NED 13	Inadequate municipal water supply.	Colorado Water Conservation Board Colorado Division of Water Quality Control Colorado Division of Water Resources Colorado Department of Local Affairs Four Corners Regional Commission
NED 14	Poor housing.	Colorado Division of Water Quality Co Colorado State Board of Land Commissioners Colorado Department of Local Affairs Four Corners Regional Commission
NED 15	Lack of recreational areas and facilities.	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers National Park Service Colorado Division of Parks and Outdoor Recreation Colorado State Board of Land Commissioners Colorado Department of Local Affairs Colorado Division of Wildlife Soil Conservation Districts Four Corners Regional Commission
NED 16	Inadequate recreational access.	Bureau of Land Management U. S. Fish and Wildlife Service Corps of Engineers National Park Service Colorado Division of Parks and Outdoor Recreation Colorado State Board of Land Commissioners Colorado Division of Water Resources Colorado Department of Local Affairs Colorado Division of Wildlife Soil Conservation Districts Four Corners Regional Commission Bureau of Reclamation

TABLE X-1

CORRELATION OF LOCAL PROBLEMS TO
NON-USDA PROGRAMS
Rio Grande Basin Colorado

NATIONAL OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	NON-USDA PROGRAMS
NED 17	Insufficient timber supply to operate existing mills at capacity. Current level of timber management will not allow basin's resources to contribute their share of nation's future needs. Significant mortality in overmature timber stands.	Colorado State Forest Service
NED 18	Fluctuating under and over utilization of recreation resources.	None
EQ 1	Wind erosion.	Colorado State Forest Service Bureau of Land Management National Park Service Colorado Water Conservation Board Colorado State Board of Land Commissioners Soil Conservation Districts Colorado Division of Wildlife Estension Service
EQ 2	Lack of recreation areas and facilities	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers National Park Service

TABLE X-1

CORRELATION OF LOCAL PROBLEMS TO

NON-USDA PROGRAMS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	NON-USDA PROGRAMS
EQ 2 -- Cont'd		Colorado Division of Outdoor Recreation Colorado State Board of Land Commissioners Colorado Division of Water Resources Colorado Department of Local Affairs Colorado Division of Wildlife Soil Conservation Districts Four Corner Regional Commission
EQ 3	Water pollution is being caused by mine drainage and agriculture runoff.	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers Colorado Water Conservation Baord Colorado Division of Water Quality Control Colorado State Board of Land Commissioners Colorado Department of Local Affairs Soil Conservation Districts Four Corners Regional Commission Environmental Protection Agency
EQ 4	Opportunities for scientific investigation and recreation in a wilderness setting may be significantly diminished.	Bureau of Land Management U. S. Fish and Wildlife Service National Park Service
EQ 5	Decreasing big game winter range.	Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Colorado Division of Wildlife Colorado Division of Parks and Outdoor Recreation
EQ 6	Big game migration routes are threatened by Urban development.	Bureau of Land Management U. S. Fish and Wildlife Service Colorado State Board of Land Commissioners Colorado Division of Wildlife Colorado Division of Parks and Outdoor Recreation Colorado Land Use Commission

TABLE X-1

CORRELATION OF LOCAL PROBLEMS TO
NON-USDA PROGRAMS
Rio Grande Basin, Colorado

NATIONAL OBJECTIVE	PROBLEMS (PUBLIC CONCERNS)	NON-USDA PROGRAMS
EQ 7	Inadequate access to public land for hunting and fishing pruposes.	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Corps of Engineers Colorado Division of Parks and Outdoor Recreation Colorado Board of Land Commissioners Colorado Division of Water Resources Colorado Division of Wildlife Four Corners Regional Commission
EQ 8	Degradation of trout habitat due to silitation of streams by road construction and timber harvest activities.	Colorado State Forest Service Bureau of Land Management Corps of Engineers Colorado Water Conservation Board Colorado State Board of Land Commissioners Colorado Division of Wildlife Soil Conservation District
EQ 9	Survival of endangered and threatened wildlife species is in jeopardy.	Bureau of Land Management U. S. Fish and Wildlife Service Bureau of Reclamation Colorado Division of Parks and Outdoor Recreation Colorado Division of Water Quality Control Colorado Division of Wildlife Soil Conservation District Four Corners Regional Commission
EQ 10	Smoke from sawmill burners degrades air quality.	Colorado State Forest Service Colorado State Board of Land Commission Colorado Department of Local Affairs Colorado State Air Pollution Control Commission Four Corners Regional Commission

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APPENDICES

WATER AND RELATED LAND RESOURCES
RIO GRANDE BASIN
COLORADO

A Report Based on a Cooperative Study by

COLORADO WATER CONSERVATION BOARD

and

UNITED STATES DEPARTMENT OF AGRICULTURE

PREPARED BY

ECONOMICS, STATISTICS, AND COOPERATIVES SERVICE - FOREST SERVICE - SOIL CONSERVATION SERVICE

DENVER, COLORADO - SEPTEMBER 1978

USDA-SCS-PORTLAND, OR. 1978

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APPENDIX A

SOILS

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APPENDIX A

CONTENTS

TABLES

SOILS

The general soil map locates soils with similar characteristics and suitability within the basin. See Plate 3. Broad characteristics and relationships can then be used to interpret the potential of soils for agricultural, recreational, commercial and industrial uses. Problems of erosion, sediment yield, land use, and future development are interrelated with soils and their distribution.

The General Soils Map was prepared by delineating 20 mapping units that differ from each other in the kinds of soil that are present. Soils in each mapping unit form patterns that are repeated from place to place.

Mapping units were defined and described according to requirements imposed by the map scale and criteria from "Soil Taxonomy" published December 1975. The soil map unit numbers in this report correspond to the soil map unit numbers of "Soils of Colorado" published July 1977.

Soils association numbers were used by the work group in preparation of mini reports and computer models. Since this time, Colorado has published a new Colorado State General Soils Map. The Index for Soils Maps (Table A-1) shows the relationship of the soil association numbers to the new mapping units.

Soil mapping units were placed in seven major groups for purposes of broad interpretation. Dominant characteristics of each mapping unit are given in Table A-2.

Group I (Green) Map Unit 1 - Typic Cryoboralfs, skeletal--Rock Outcrop, sloping to steep.

This map unit constitutes 25 percent of the basin. These soils occupy timbered mountain slopes, high plateaus, mesas, sparsely vegetated escarpments and rock outcrops. Valleys are narrow and inextensive. Slopes are frequently broken by ledges and escarpments. The soils formed in materials weathered from a variety of crystalline and sedimentary rocks.

Elevations range from 7,500 to 11,500 feet (2,286 to 3,505 m). Slopes commonly range from 5 to 65 percent but areas of rock outcrop may have escarpments or canyon walls with almost vertical cliffs. The annual precipitation ranges from about 20 to 40 inches (0.51 to 1.02 m) and most of it comes as snow. The mean annual soil temperature is about 35 to 45 degrees F. (1.7 to 7.2° C) and the frost free season is about 0 to 75 days. This map unit covers about 1,207,000 acres (488,473 ha), - 1,886 square miles (4,885 km^2).

TABLE A-1

INDEX FOR SOILS MAPS
Association Numbers to Mapping Units

Rio Grande Basin, Colorado

ASSOCIATION NUMBER 1972 Colorado-Counties-General Soils Map	MAPPING UNIT 1977 Soils of Colorado
49	1
104,118,124	5
109,126	7
105,106	17
108,125	19
114	22
106	27
123	43
102,107,110	44
48,49,64	47
101,102,103,121,122	48
119	49
49,112,120	50
51	55
49,50,51,116	56
97,117	57
50,51,97,120	58
115,116,124	60
64,113	61
111	80

Table A-2
Dominant Characteristics of Soil Mapping Units, Rio Grande Basin, Colorado 1/

Rio Grande Basin, Colorado

Group	Map Unit	Percent of Basin	Elevation (Feet) (m)	Mean Annual Precip. (Inches) (m)	Mean Annual Soil Temp. F (c)	Frost-free Period Days	Plant Cover Type	Soil Depth	Parent Material	Slope Percent	Major Land Use	Potential for Irrigation
I (Green)	1	25.0	7,500-11,500 (2,286-3,505)	20-40 (0.51-1.02)	35-45 (1.7-7.2)	0-75	Spruce, Fir Pine, Aspen	Moderately Deep to Deep	Weathered materials	5-65	Wildlife Recreation	None
II (Blue)	5	7.6	7,500-8,000 (2,286-2,438)	7 (0.18)	45 (7.2)	95	Greasewood, Rabbitbrush, Grasses	Deep	Mixed Alluvium	0-5	Range, Irrigated Crop & Pasture	Moderate
	7	10.4	8,000-9,000 (2,438-2,743)	8-12 (0.2-0.3)	45 (7.2)	90-100	Rabbitbrush, Grasses	Deep	Mixed Alluvium	0-15	Range Irrigated Crop & Pasture	Moderate
	17	6.3	7,500-7,600 (2,286-2,317)	7 (0.18)	45 (7.2)	95	Greasewood, Rabbitbrush	Deep	Alluvium Wind Deposits	0-2	Range, Irrigated Crops	Moderate
	19	1.0	8,000-8,500 (2,438-2,591)	10-15 (0.25-0.38)	40-45 (4.4-7.2)	80	Brush, Grasses	Deep	Alluvium	0-15	Range	Low
	22	2.4	7,800-9,000 (2,377-2,743)	10-15 (0.25-0.38)	40-45 (4.4-7.2)	70-100	Brush, Grasses	Shallow	Weathered materials	0-30	Wildlife Range	Low
III (Yellow)	27	2.3	7,500 (2,286)	7 (0.18)	45 (7.2)	95	Greasewood, Grasses	Deep	Mixed Alluvium	0-2	Irrigated Cropland Range	Moderate
	43	0.8	7,500 (2,286)	7 (0.18)	45 (7.2)	95	Non-Existent	Deep	Mixed Alluvium	0-2	Irrigated Cropland	Moderate to High
IV (Orange)	44	3.8	7,600-8,000 (2,317-2,438)	8 (0.2)	45 (7.2)	95	Grasses	Deep	Alluvium Wind Deposits	0-30	Range, Recreation Wildlife	None
V (White)	47	6.8	11,000-14,500 (3,353-4,420)	30-50 (0.76-1.27)	30-35 (-1.1-1.67)	0	Forbs, Shrubs, Grasses	Shallow to Moderate	Weathered materials	0-50	Wildlife Recreation	None
VI (Brown)	48	4.5	7,500 (2,286)	7 (0.18)	45 (7.2)	95	Grasses	Deep	Mixed Alluvuim	0-2	Irrigated Hay & Pasture Wildlife & Range	Moderate to High
	49	0.7	7,800-10,000 (2,377-3,048)	12-20 (0.31-0.51)	30-45 (-1.1-7.2)	30-90	Brush, Grasses	Deep	Mixed Alluvium	0-5	Irrigated Hay & Pasture, Wildlife	Low
	50	3.1	8,000-11,000 (2.438-3,353)	10-20 (0.25-0.51)	40-45 (4.4-7.2)	30-75	Pine, Juniper, Grasses	Shallow to Deep	Weathered materials	2-50	Range, Wildlife Recreation	None
	55	2.4	8,000-10,500 (2,438-3,200)	15-20 (0.38-0.51)	38-42 (3.3-5.6)	25-65	Grasses, Brush	Shallow to Deep	Coarse, textured alluvium	0-50	Range, Wildlife	None
	56	5.8	7,000-11,500 (2,134- 3,505)	15-25 (0.38-0.64)	35-42 (1.7-5.6)	20-85	Spruce, Fir, Pine, Aspen, Brush, Grasses	Moderate to Deep	Weathered materials	15-50	Range, Recreation, Wildlife	None
	57	0.5	8,000-10,000 (2,438-3,048)	15-20 (0.38-0.51)	40-45 (4.4-7.2)	45-85	Oak, Pine, Brush, Grasses	Moderate to Deep	Weathered materials	3-50	Range, Wildlife	None
	58	7.0	8,000-11,000 (2,438- 3,353)	15-30 (0.38-0.76)	38-45 (3.3-7.2)	30-75	Brush, Grasses	Moderate to Deep	Coarse, textured alluvium	2-50	Range, Wildlife	None
	60	3.1	7,500-8,500 (2,286-2,591)	15-20 (0.38-0.51)	40-47 (4.4-8.3)	75-125	Oak, Brush Grasses	Moderate to Deep	Coarse, textured alluvium	2-45	Range, Irrigated Cropland, Recreation	None
	61	4.7	8,000-10,000 (2,438-3,048)	15-24 (0.38-0.61)	42-47 (5.5-8.3)	80-125	Pine, Fir, Shrubs, Grasses	Shallow	Weathered materials	15-50	Wildlife, Recreation, Range	None
VII (Pink)	80	0.8	7,800-8,800 (2,377-2,682)	9 (0.23)	40 (4.4)	95	None	Deep	Wind Deposits	Dunes 5-65	Recreation	None

1/ Source: "Soils of Colorado," July 1977.

LEGEND

GROUP I — ALFISOLS

BORALFS

- Typic Cryoboralfs, skeletal- Rock Outcrop sloping to steep

GROUP II — ARIDISOLS

ARGIDS

- 5 Typic Haplargids, loamy- Typic Torriorthents, skeletal: nearly level and gently sloping
- Borollic Haplargids- Borollic Calciorthids: loamy; nearly level to sloping
- 17 Typic Natrargids, clayey- Typic Torripsamments: nearly level to moderately steep

ORTHIDS

- 19 Typic Calciorthids, skeletal- Borollic Calciorthids, loamy: nearly level to sloping
- Borollic Lithic Camborthids, skeletal- Rock Outcrop; gently sloping to steep

GROUP III — ENTISOLS

AQUENTS

- Typic Psammaquents- Typic Natrargids, loamy- Aquic Natrargids, loamy: nearly level

ORTHENTS

- Typic Ustorthents: skeletal; nearly level

GROUP IV

PSAMMENTS

- Typic Torripsamments: nearly level to steep

GROUP V — INCEPTISOLS

UMBREPTS

- 47 Pergelic Cryumbrepts, skeletal- Pergelic Cryochrepts, skeletal- Rock Outcrop: sloping to steep

GROUP VI — MOLLISOLS

AQUOLLS

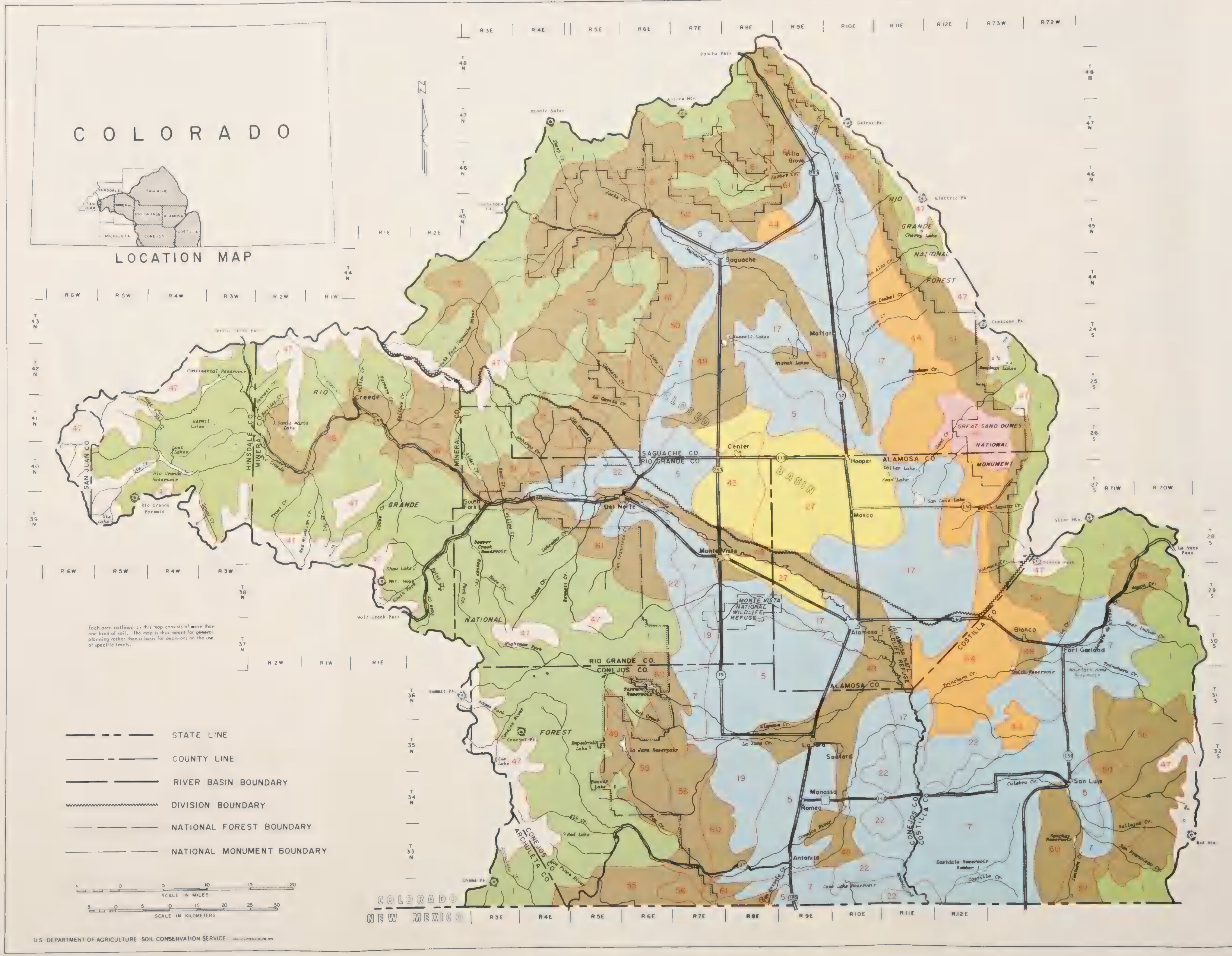
- Typic Argiaquolls, loamy- Aeric Halaquepts, clayey- Typic Haplaquolls, loamy: nearly level
- Typic Cryaquolls- Argic Cryaquolls, loamy- Cumulic Cryaquolls: loamy; nearly level and gently sloping

BOROLLS

- Aridic Argiborolls- Lithic Argiborolls: skeletal; sloping to steep
- 55 Typic Cryoborolls, loamy- Rock Outcrop: sloping to steep
- 56 Typic Cryoborolls, clayey- Typic Cryoboralfs, skeletal: moderately steep and steep
- Typic Cryoborolls- Typic Cryothents : clayey; sloping to steep
- 58 Argic Cryoborolls- Typic Cryoborolls: loamy; gently sloping to steep
- Aridic Haploborolls, loamy- Torriorthentic Haploborolls, loamy- Aridic Argiborolls, clayey: gently sloping to steep
- Lithic Haploborolls, skeletal- Rock Outcrop: moderately steep and steep

GROUP VII — LAND TYPE

- Dune Land



GENERAL SOIL MAP
RIO GRANDE BASIN
COLORADO
1978

PLATE 3

This map unit is used mainly for a combination of recreation, wildlife habitat, water supply and wood production uses with some areas also being used for grazing by domestic livestock. The native vegetation is mainly Engelmann spruce, subalpine fir, lodgepole pine, limber pine and aspen. Shrubs, forbs, and grasses range from sparse in the densely timbered areas to moderate where trees have been harvested or destroyed. The cold climate, steep slopes, stony soils and rock outcrops are major limiting factors to more intensive uses. The natural beauty in areas of this map unit combined with its good to fair woodland wildlife potential lead to high demands in recreational uses. Selected areas have only slight limitation for camp areas, picnic areas, and paths and trails. Hunting, fishing and skiing are major recreational uses.

Soils - Group 1 [Green]
Timbered mountain slopes used for timber production, recreation, and wildlife habitat.

Group II (Blue)

This group consist of five map units: 5, 7, 17, 19, and 22.

Soils - Group II [Blue]
Alluvial fans - Rangeland and irrigated croplands.

Map Unit 5 - Typic Haplargids, loamy--Typic Torriorthents, skeletal; nearly level and gently sloping.

This map unit constitutes 7.6 percent of the basin. It is only in the Rio Grande Basin. The soils in this unit occupy alluvial fans, terraces and floodplains. The soils are formed from mixed alluvium.

Elevations range from about 7,500 to 8,000 feet (2,286 to 2,438 m). Slopes range from 0 to 5 percent. The average annual precipitation is about 7 inches (0.18 m). The mean soil temperature is about 45 degrees (7.2° C) and the frost free season is approximately 95 days. This map unit covers about 368,000 acres (148,930 ha) - 575 square miles (1,489 km^2).

This map unit is used mostly as rangeland but about one-fourth of the total acreage is irrigated for crop and pasture production. Native vegetation is a mixture of salt tolerant shrubs and grasses in open and often patchy stands. Greasewood and rabbitbrush are dominant. Alkali sacaton, western wheatgrass and saltgrass are in the understory. Potatoes, alfalfa and barley are the important irrigated crops.

Excess salts, low available water capacity and cold climate are the primary limiting factors to irrigated crop production. Soils are only slightly limited for most non-agricultural uses except in locations where irrigation has raised the water table.

Map Unit 7 - Borollic Haplargids; loamy--Borollic Calciorthids, loamy; nearly level to sloping.

This map unit constitutes 10.4 percent of the basin. The soils in this unit occupy alluvial fans and valley sideslopes. The soils are formed in mixed alluvium.

Elevations range from about 8,000 to 9,000 feet (2,438 to 2,743 m). Slopes range from 0 to 15 percent. The average annual precipitation ranges from 8 to 12 inches (0.2 to 0.3 m). The mean annual soil temperature is about 45 degrees F. (7.2° C) and the frost free season is approximately 90 to 110 days. This map unit covers about 502,000 acres (203,159 ha) - 784 square miles (2,031 km^2).

This unit is used mostly as rangeland, but a few areas are irrigated for production of both pasture and crops. Native vegetation is a sparse stand of rabbitbrush, winterfat, Indian ricegrass, blue grama, sand dropseed and needle grasses. Barley, potatoes and alfalfa are the principal irrigated crops. Most of the irrigated pastures are a mixture of grasses and sedges.

Map Unit 17 - Typic Natrargids, clayey--Typic Torripsamments; nearly level to moderately steep.

This map unit constitutes 6.3 percent of the basin. The unit occupies a nearly level basin floor and intermingled sand dunes and ridges. The soils are formed in alluvial materials and wind-deposited sands.

Elevations over the unit range from about 7,500 to 7,600 feet (2,286 to 2,317 m). Slopes are dominantly 0 to 2 percent over most of the unit but range up to 15 percent in the dune areas. The average annual precipitation is about 7 inches (0.18 m). The mean annual soil temperature is about 45 degrees F. (7.2° C) and the frost free season is approximately 95 days. This map unit covers about 304,000 (123,029 ha) - 475 square miles (1,230 km^2).

This map unit is used mainly as rangeland. There is some irrigated cropping, primarily on the arable included soils. Native vegetation is dominated by greasewood and rabbitbrush with scattered patches of saltgrass and alkali sacaton. Large areas have no vegetation other than scattered greasewood.

Excess alkali severely limits cropland potentials. Soil blowing, dustiness, corrosivity are limitations to non-agricultural uses. Half the area is limited by high shrink swell and low strength of the soils.

Map Unit 19 - Typic Calciorthids, skeletal--Borollic Calciorthids, loamy; nearly level and sloping.

This map unit constitutes 1.0 percent of the basin. The soils in this unit occupy alluvial fans and valley sideslopes. The soils are formed in calcareous alluvial fan sediment principally from basalt and soft sedimentary rocks.

Elevations range from about 8,000 to 8,500 feet (2,438 to 2,591 m). Slopes range from 0 to 15 percent. The average annual precipitation ranges from 10 to 15 inches (0.25 to 0.38 m). The mean annual soil temperature is about 40 to 45 degrees F. (4.4 to 7.2° C) and the frost free season is approximately 80 days. This map unit covers about 47,000 acres (19,021 ha) - 73 square miles (189 km^2).

This map unit is used almost entirely as rangeland. Native vegetation is dominated by winterfat, fourwing saltbush, fringed sage, Indian ricegrass and blue grama.

Dry cold climate, shallow soils and excess lime are limitations to use as cropland. Dustiness, depth to rock, piping hazard, and low strength are limitations to non-agricultural uses. Some areas also have excess slope.

Map Unit 22 - Borollic Lithic Camborthids, skeletal--Rock Outcrop; gently sloping to steep.

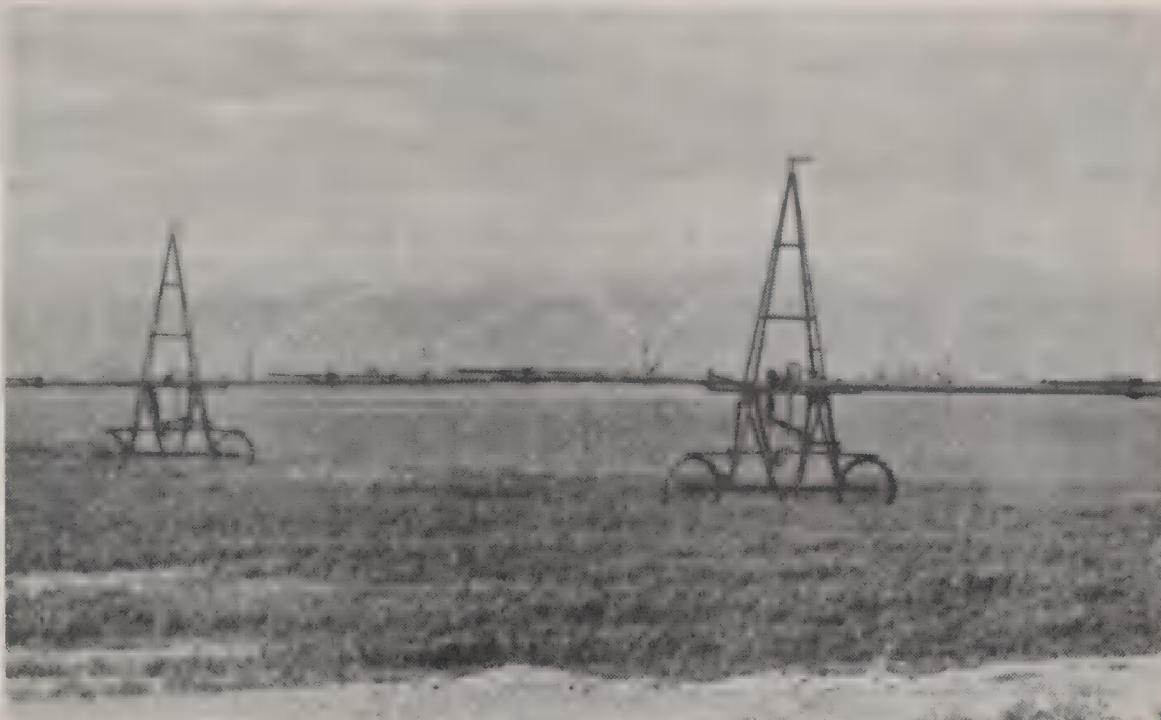
This map unit constitutes 2.4 percent of the basin. The soils occupy mesas, alluvial fans and sideslopes. The soils are formed in materials weathered residually from basalt and in calcareous alluvium from soft sedimentary rocks.

Elevations range from 7,800 to 9,000 feet (2,377 to 2,743 m). Slopes range from 2 to 30 percent except where rock outcrop occurs and here almost vertical cliffs may occur. The average annual precipitation ranges from 10 to 15 inches (0.25 to 0.38 m). The mean annual soil temperature is about 40 to 45 degrees F. (4.4 to 7.2° C) and the frost free season is approximately 70 to 100 days. This map unit covers about 118,000 acres (47,755 ha) - 184 square miles (477 km^2).

This map unit is used for rangeland but also receives some grazing by deer. Native vegetation is a sparse stand of winterfat, rabbitbrush, saltbush, blue grama and Indian ricegrass.

Depth to rock, stoniness and slope are limiting all uses.

Group III - (Yellow) This group consists of two map units: 27 and 43.



Soils - Group III [Yellow]
Irrigated cropland on floodplains and alluvial fans.

Map Unit 27 - Typic Psammaquents--Typic Natrargids, loamy--Aquic Natrargids, loamy, nearly level.

This map unit constitutes 3.3 percent of the basin. The soils in this unit occupy slightly depressed flood plains and low alluvial fans on the basin floor. The soils are formed in mixed fine to coarse textured sandy alluvium.

Elevation is about 7,500 feet (2,286 m). Slopes are 0 to 2 percent. The average annual precipitation is about 7 inches (0.18 m). The mean annual soil temperature is about 45 degrees F. (7.2^{o} C) and the frost free season is approximately 95 days. This map unit covers about 158,000 acres (63,943 ha) - 247 square miles (640 km^2).

This map unit is used as irrigated cropland and rangeland. Native vegetation is greasewood, rabbitbrush, alkali sacaton and saltgrass. Alfalfa, potatoes and barley are the most extensively grown irrigated crops. Some irrigated areas have only grass-sedge pasture.

The short frost free season along with excess salts, soil blowing hazard and low available water capacity is limiting to irrigated crop production. Seasonal water tables and corrosivity are limiting to non-agricultural uses.

Map Unit 43 - Typic Ustorthents, skeletal, nearly level.

This map unit constitutes 0.8 percent of the basin. The soils in this unit primarily occupy broad alluvial fans or terraces. The dominant soils are formed in gravelly and sandy alluvium.

Elevation is about 7,500 feet (2,286 m). Slopes are 0 to 2 percent. The average annual precipitation is about 7 inches (0.18 m). The mean annual soil temperature is about 45 degrees F. (7.2° C) and the frost free season is approximately 95 days. This map unit covers about 40,000 acres (16,188 ha) - 63 square miles (163 km^2).

This map unit is used almost entirely as irrigated cropland. Subirrigation is extensive. Native vegetation is almost non-existent, but was originally rabbitbrush, greasewood, sacaton, blue grama, and squirreltail. Major crops are potatoes, barley, and alfalfa. Some lettuce, peas, spinach, cabbage and cauliflower are also grown.

Low available water capacity and cold climate are the primary limitations for use as irrigated cropland. High water table and frost action are the limiting soil factors to non-agricultural uses.

Soils - Group IV [Orange]
Rangelands occupying ridges, dunes, and floodplains.

Group IV - (Orange)

Map Unit 44 - Typic Torripsamments, nearly level to steep.

This map unit constitutes 3.8 percent of the basin. The soils in this unit occupy fans, ridges, dunes and floodplains. They are mostly formed in wind deposited sand from wind worked alluvium.

Elevations range from about 7,600 to 8,000 feet (2,317 to 2,438 m). Slopes range from 0 on the floodplains up to about 30 percent in the dune areas. The average annual precipitation is about 8 inches (0.2 m). The mean annual soil temperature is about 45 degrees F. (7.2° C) and the frost free season is approximately 95 days. This map unit covers about 184,000 acres (74,465 ha) - 288 square miles (746 km^2).

This map unit is nearly all rangeland. Some areas are set aside for recreation use and wildlife is a secondary use in many areas. Native vegetation is mostly Indian ricegrass, needlegrass, spike dropseed, sand dropseed and saltbush.

The very low annual precipitation, soil blowing, and low available water capacity are limiting to agricultural uses. Dustiness, sandiness, and slope are limiting to non-agricultural use.

Group V - (White)

Map Unit 47 - Pergelic Cryumbrepts, skeletal--Pergelic Cryochrepts, skeletal--Rock Outcrops; sloping to steep.

This map unit constitutes 6.8 percent of the basin. The soils in this unit occupy alpine slopes, and alpine meadows and the unit includes massive mountain peaks, rock outcrops and rock slides. The soils are formed in materials weathered in place or locally transportedz!argely from crystalline rocks.

Elevation ranges from about 11,000 to 14,500 feet (3,353 to 4,429 m). Slopes dominantly range from 2 to 50 percent. The average annual precipitation ranges from 30 to 50 inches (0.76 to 1.27 m). The mean soil temperatures is about 30 to 35 degrees F. (-1.1 to 1.67° C) and freezing temperatures occur in every month of the year. This map unit covers 332,000 acres (134,360 ha) - 518 square miles (1,343 km^2).

This map unit is used almost exclusively as wildlife, recreation, and watershed lands; however, there is limited grazing by sheep in some areas. About half the area is unvegetated except for mosses and lichens on the rocks. A wide variety of alpine forbs and shrubs along with a few grasses and sedges vegetate the turf like slopes. Willows, sedges and tufted hairgrass dominate the plant cover on the moist or meadowlike concave slopes.

Erosion hazard is high on this unit and revegetation of eroded areas is slow and difficult. This unit is severely limited for all uses that in any way disturb the vegetation.

Soils - Group V [White]
Alpine ecosystem - Recreation, wildlife, and watershed.

Group VI - (Brown)

This group consist of nine map units - 48, 49, 50, 55, 56, 57, 58 60, and 61.

Map Unit 48 - Typic Argiaquolls, loamy--Aeric Halaquepts, clayey--Typic Hapaquolls, loamy, nearly level.

Map Unit 48

Map Unit 58

Soils - Group VI [Brown]
Irrigation cropland, pastureland, timber production, recreation and wildlife.

This map unit constitutes 4.5 percent of the basin. These soils occupy flood plains, low terraces and alluvial fans and are formed in mixed alluvium.

The elevation is about 7,500 feet (2,286 m). Slopes are less than 2 percent. The average annual precipitation is about 7 inches (0.18 m). The mean annual soil temperature is about 45 degrees F. (7.2° C) and the frost free season is approximately 95 days. This map unit covers about 219,000 acres (88,629 ha) - 342 square miles (886 km^2).

This map unit is used principally for irrigated hay and pasture, irrigated cropland, wetland wildlife habitat, and as rangeland. Native vegetation is dominantly tufted hairgrass, alkali sacaton, wheatgrasses and sedge. Where drains are installed, potatoes and barley are common irrigated crops.

Poor drainage, excess salts, and cold climate are major limitations to irrigated crop production, and poor drainage and flooding severely limit the potential for most non-agricultural uses. The potential for wetland wildlife habitat development is good.

Map Unit 49 - Typic Cryaquolls, loamy--Argic Cryaquolls, loamy--Cumulic Cryaquolls, loamy nearly level and gently sloping.

This map unit constitutes 0.7 percent of the basin. The soils in this unit occupy high mountain meadow areas on floodplains, low terraces and fans. The soils are formed in mixed alluvium.

Elevation ranges from about 7.800 to 10,000 feet (2,377 to 3,048 m). Slopes range from 0 to 5 percent. The average annual precipitation ranges from 12 to 20 inches (0.31 to 0.51 m). The mean annual soil temperature ranges from 35 to 45 degrees F. (1.67 to 7.2° C) and the frost free season is approximately 30 to 90 days. This map unit covers 35,000 acres (14,165 ha) - 54 square miles (140 km^2).

This map unit is nearly all used for irrigated hay or pasture. A few of the wettest areas are used for wildlife. Native vegetation is mostly sedge, rush and tufted hairgrass with willows adjacent to streams. The more improved fields have clovers or alfalfa added for hay production.

Poor drainage and short growing season are limiting to irrigated crop production. Wetness and flooding are limiting to non-agricultural uses.

Map Unit 50 - Aridic Argiborolls, skeletal--Lithic Argiborolls, skeletal sloping to steep.

This map unit constitutes 3.1 percent of the basin. The soils in this unit occupy fans, foothills, and mountain side slopes. The soils are dominantly formed in materials weathered from a variety of igneous and metamorphic rocks.

Elevations range from about 8,000 to 11,000 feet (2,438 to 3,353 m). Slopes range from 2 to 50 percent. The average annual precipitation ranges from about 10 to 20 inches (0.25 to 0.51 m). The mean soil temperature is about 40 to 45 degrees F. (4.4 to 7.2° C) and the frost free season is approximately 30 to 75 days. This map unit covers about 150,000 acres (60,705 ha) -234 square miles (606 km^2).

This map unit is used mainly as rangeland but is also used by wildlife and for recreation. Native vegetation is dominated by Pinyon pine and Juniper with an understory of wheat and needle grasses, Indian ricegrass, squirreltail and muttongrass.

Droughtiness, stones, and slope are limiting to agricultural uses. The slope and depth to bedrock are limiting to most non-agricultural uses; however, selected areas have good potential for cabin and homesites.

Map Unit 55 - Typic Cryoborolls, loamy--Rock Outcrop, sloping to steep.

This map unit constitutes 2.4 percent of the basin. The soils in this unit occupy subalpine mountain slopes, mesas, upland benches, and old high terraces and fans. The soils are formed in a wide variety of materials consisting of glacial till and outwash, weathered sandstone, shale disintegrated granite, and stony and cobbly coarse textured alluvium. Rocky outcrop makes up about 20 percent of this unit.

Elevation ranges from about 8,000 to 10,500 feet (2,438 to 3,200 m). Slopes range from about 2 to 50 percent. The average annual precipitation ranges from about 15 to 20 inches (0.38 to 0.51 m). The mean soil temperature is about 38 to 42 degrees F. (3.3 to 5.6° C) and the frost free season is approximately 25 to 65 days. This map unit covers 118,000 acres (47,755 ha) - 184 square miles (477 km^2). This unit is used almost entirely as rangeland; however, many areas adjacent to streams are irrigated to produce hay or pasture. Elk and deer frequent most of the areas, particularly during winter months for food. Native vegetation is a sparse cover of muttongrass, western wheatgrass, pine needlegrass and in some areas big sagebrush. Where irrigated, sedges, tufted hairgrass, timothy, red top and rushes are dominant.

The dry cold climate and broken slopes are limiting to agricultural uses. Slopes, rock outcrops, and shallow soils limit the potential for non-agricultural uses other than for wildlife.

Map Unit 56 - Typic Cryoborolls, clayey--Typic Cryoboralfs, skeletal, moderately steep and steep.

This map unit constitutes 5.8 percent of the basin. The soils in this unit dominantly occupy mountain slopes. The soils are formed in materials largely weathered in place from shale and sandstone at the lower elevations and from igneous and metamorphic rocks at the higher elevations.

Elevations range from about 7,000 feet to 11,500 feet (2,134 to 3,505 m). Slopes range from about 15 to 50 percent. The average annual precipitation ranges from 15 to 25 inches (0.38 to 0.64 m). The mean soil temperature is about 35 to 42 degrees F. (1.7 to 5.6^{o} C) and the frost free season is approximately 20 to 85 days. This map unit covers about 280,000 acres (113,316 ha) - 437 square miles (1,132 km^2).

This map unit is used as grazeable woodland, rangeland, recreation land, wildlife habitat and in a few areas for woodland harvest. A few included areas are used for irrigated hay and pasture. Native vegetation is quite variable; spruce-fir, aspen and lodgepole pine dominate most of the north facing exposures. Ponderosa pine, oakbrush, big sagebrush with grass understory are dominant on the other exposures.

Cold climate and slope are limiting to agricultural uses. Potential for continued change in use to recreation is good even though slopes are limiting to many areas. Potential for development of additional ski areas is good. Potential for increased wildlife developments is also good.

Map Unit 57 - Typic Cryoborolls, clayey--Typic Cryorthents, clayey, sloping to steep.

This map unit constitutes 0.5 percent of the basin. The dominant soils in this unit occupy benches, mountain slopes, and alluvial fans and are formed in materials weathered in place from shale or sandstone. Some of the smaller areas of this unit occupy alluvial fans and old, high terraces and valley filled sideslopes. The soils in these areas are formed in materials locally transported from weathered sedimentary rocks.

Elevations range from about 8,000 to 10,000 feet (2,438 to 3,048 m). Slopes range from about 3 to 50 percent. The average annual precipitation ranges from about 15 to 20 inches (0.38 to 0.51 m). The mean soil temperature is about 40 to 45 degrees F. (4.4 to 7.2^{o} C) and the frost free season is approximately 45 to 85 days. This map unit covers about 22,000 acres (8,903 ha) - 34 square miles (88 km^2).

This map unit is used primarily as rangeland, grazeable woodland and as wildlife land. Native vegetation is mostly Gambel oak with clusters of Ponderosa pine and open parks of big sagebrush, fescue, wheat, blue and needlegrass.

Slopes and cold climate limit agricultural uses and potential. Low strength, shrink-swell and slopes are limiting to non-agricultural uses; however, selected sites have good potential for cabin and recreational development. Potential for expanded wildlife habitat development, particularly for deer is good.

Map Unit 58 - Argic Cryoborolls, loamy--Typic Cryoborolls, loamy, gently sloping to steep.

This map unit constitutes 7.0 percent of the basin. The soils in this unit occupy benches, mountain slopes, high terraces, hills, ridges, fans, till plains, moraines, and valley sideslopes. They are formed in residuum from a variety of crystalline and sedimentary rocks, glacial outwash, and colluvial-alluvial material.

Elevations range from about 8,000 to 11,000 feet (2,438 to 3,353 m). Slopes range from 2 to 50 percent. The mean annual precipitation ranges from 15 to 30 inches (0.38 to 0.76 m). The mean soil temperature is about 38 to 45 degrees F. (3.3 to 7.2^{o}) and the frost free season is approximately 30 to 75 days. This map unit covers about 337,000 acres (136,384 ha) - 526 square miles (1,362 km^2).

This unit is used almost exclusively as rangeland, grazed by both cattle and sheep, but most areas are also grazed by deer. Native vegetation is usually dominated by big sagebrush. Wheat grasses, fescues, bromes, blue grasses and elk sedge furnish most of the forage for grazing.

The cold climate is severely limiting to all but the most frost tolerant crops and the low summer precipitation and steep slopes reduce the suitability for even these.

Steep slopes, shrink-swell, frost action and frequent stoniness are limiting soil factors to non-agricultural uses.

Map Unit 60 - Aridic Haploborolls, loamy--Torriorthentic Haploborolls, loamy--Aridic Argiborolls, clayey, gently sloping to steep.

This map unit constitutes 3.1 percent of the basin. The soils in this unit occupy mountain slopes, mesas, and canyons, in the form of terraces, fans, valley side slopes, narrow valleys and flood plains. The soils over most of the unit are formed in materials weathered in place from sandstone, shale and igneous rocks. Most of the soils in the smaller areas of this unit are formed in gravelly, sandy and cobbly alluvium and glacial outwash.

Elevations range from about 7,500 to 8,500 feet (2,286 to 2,591 m). Slopes range from about 2 to 45 percent. The average annual precipitation ranges from 15 to 20 inches (0.38 to 0.51 m). The mean soil temperature is about 40 to 47 degrees F. (4.4 to 8.3^{o} C) and the frost free period is approximately 75 to 125 days. This map unit covers 150,000 acres (60,705 ha) - 234 square miles (606 km^2).

This map unit is used as rangeland, irrigated cropland, and recreation and homesite development. Native vegetation in most areas is Gambel oak and big sagebrush with an understory of fescue, wheat, needle and blue grasses. Some areas have Pinyon and Juniper and others have clusters of Ponderosa pine and aspen.

Cold climate and slope are the major limitations to agricultural potential. The close proximity to major recreation (ski) areas, and the natural beauty of the area lead to a high potential for development of homesites, recreation, and related commercial developments.

Map Unit 61 - Lithic Haploborolls, skeletal--Rock Outcrop, moderately steep and steep.

This map unit constitutes 4.7 percent of the basin. The soils in this unit occupy mountain slopes, foothills, and ridges (hogbacks) formed by uplifted sedimentary rocks, and colluvial materials from these rocks. Slopes are moderately steep and steep.

The elevation ranges from about 8,000 to 10,000 feet (2,438 to 3,048 m). Slopes range from 15 to 50 percent. The average annual precipitation ranges from 15 to 24 inches (0.38 to 0.61 m). The mean soil temperature is about 42 to 47 degrees F. (5.5 to 8.3^{o} C) and the frost free season is approximately 80 to 150 days. This map unit covers 224,000 acres (90,653 ha) - 350 square miles (907 km^2).

This map unit is used primarily as grazeable woodland, wildlife and recreation land; however, it is being developed extensively for cabins and summer homes. Native vegetation is mostly Ponderosa pine, Douglas fir, or Lodgepole pine with many open parks of mixed shrub and grasses.

Droughtiness and steep slope severely limit agricultural potential. The depth to bedrock and slopes also are limitations to non-agricultural uses; however, selected areas have fair to good potential for homesite development and demand for this use is high.

Group VII - (Pink)

Map Unit 80 - Dune land.

This map unit constitutes 0.8 percent of the basin. This map unit has no true soil. The area consists of a great expanse of the highest piled inland sand dunes in the United States. This sand has been deposited by southwesterly winds that blow across the basin moving the sands eastward to accumulate at the base of the mountains.

Elevations range from abut 7,800 to 8,800 feet (2,377 to 2,682 m). Slopes on the dunes range from about 5 percent on the windward to about 65 percent on the crescent faced lee side. Average annual precipitation is about 9 inches (0.23 m) and mean temperature is about 40 degrees F. (4.4^{o} C). This map unit covers about 37,000 acres (14,974 ha) - 58 square miles (150 km^2).

Soils - Group VII [Pink]
Sand Dunes

APPENDIX B

LAND USE AND VEGETAL COVER

APPENDIX B

CONTENTS

LAND USE AND VEGETATIVE COVER

Cover conditions vary from dense virgin forest to nearly barren areas. Total water production follows the same pattern and is generally related to the same factors of elevation, exposure, and effective climate that produce the variations in cover.

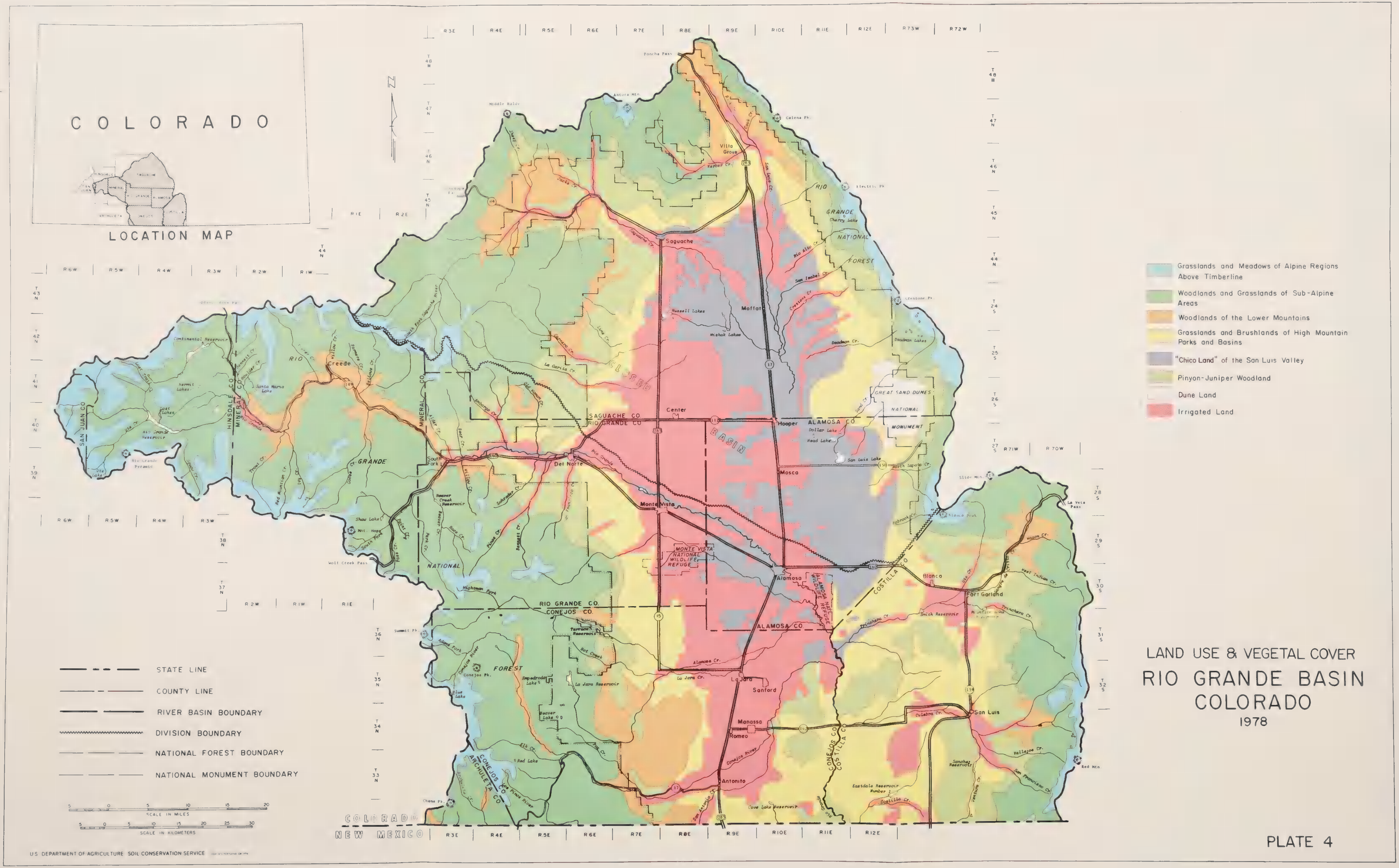
Management of the plant cover is of particular importance because of the limited growth allowed by climate and precipitation. Sediment production is directly related to the kind and amount of plant cover. Most of the higher sediment producing areas are the more arid, poorly vegetated soils.

The following is a general description of plant cover communities as they exist throughout the basin. The categories of cropland, urban, water and barren are included in this general description in lieu of plant cover. The plant biotic communities used as categories in this section are basically equivalent to ecological units or associations; thus, these terms should be considered synonymous.

This section is concerned with vegetative cover which is quite distinct from land use. For example, commercial timber production is a use of some forest lands but certainly not of all. Grazing of cattle as a land use occurs on both range and forested lands.

Plant cover is extremely significant to the planner in that it is an excellent indicator of the use potential of the land. Alpine biotic communities, due to their delicate balance, cannot absorb more than minimal use. Their two primary uses to man are as watershed and as an opportunity for a visually aesthetic experience. Contrasted with the fragility of the alpine community is the stability of the forest association. Here, manipulation of the biotic community is more successful as long as all ecological factors are taken into account. The major present products of the forest are forage, recreation, water, wildlife and wood. The range biotic communities are, for the most part, stable. However, areas of extremely low rainfall may exhibit retarded recuperation following disturbance. The major function of rangeland vegetation is for production of forage. This biotic community, however, additionally serves as a vital protective cover against wind and water erosion and supports many game and non-game wild animals.

Symbol and/or color references are included in parenthesis for those types shown on the Land Use and Vegetation Cover Map. (Plate 4.)

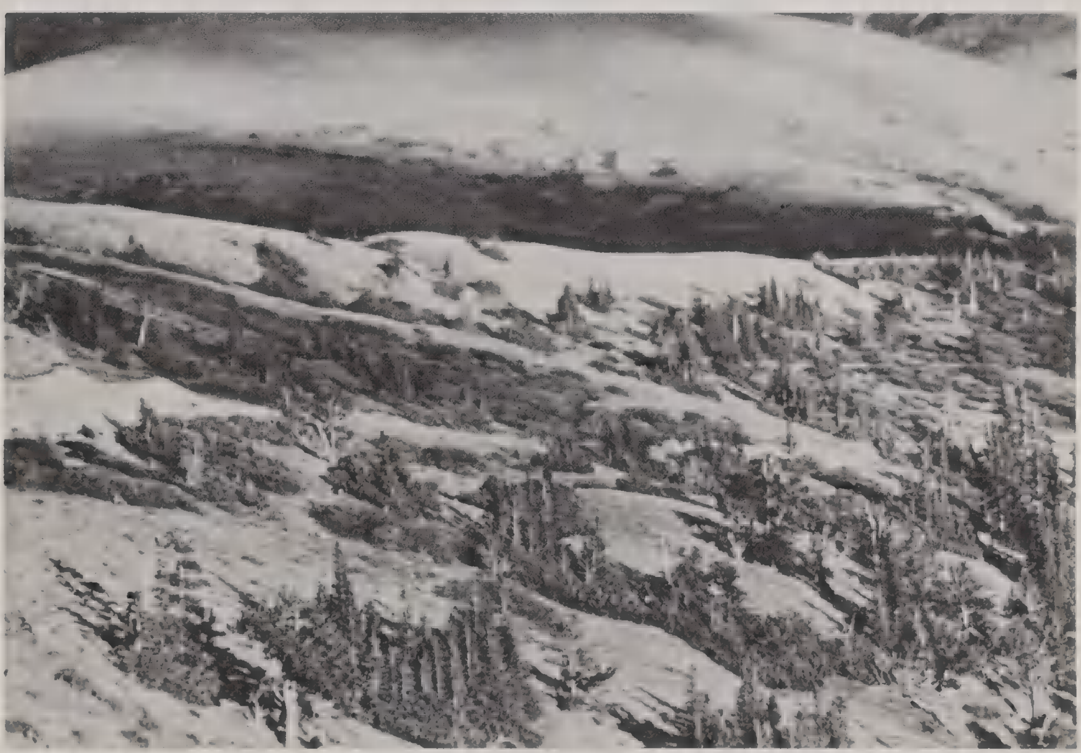

COLORADO
LOCATION MAP
Grasslands and Meadows of Alpine Regions Above Timberline
Woodlands and Grasslands of Sub-Alpine Areas
Woodlands of the Lower Mountains
Grasslands and Brushlands of High Mountain Parks and Basins
"Chico Land" of the San Luis Valley
Pinyon-Juniper Woodland
Dune Land
Irrigated Land
STATE LINE
COUNTY LINE
RIVER BASIN BOUNDARY
DIVISION BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL MONUMENT BOUNDARY
SCALE IN MILES
SCALE IN KILOMETERS
LAND USE & VEGETAL COVER
RIO GRANDE BASIN
COLORADO
1978
PLATE 4
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE
Saguache
Villa Grove
Moffat
Center
Hooper
Mosca
Alamosa
Monte Vista
Del Norte
South Fork
Creede
Blanco
Fort Garland
San Luis
La Jara
Sanford
Manassa
Romeo
Antonito
SAGUACHE CO.
RIO GRANDE CO.
ALAMOSA CO.
CONEJOS CO.
COSTILLA CO.
MINERAL CO.
HINSDALE CO.
SAN JUAN CO.
ARCHULETA CO.
GREAT SAND DUNES NATIONAL MONUMENT
MONTE VISTA NATIONAL WILDLIFE REFUGE
ALAMOSA NATL. WILDLIFE REFUGE
RIO GRANDE NATIONAL FOREST
CLOSED BASIN
COLORADO
NEW MEXICO

A. Grasslands and Meadows of Alpine Regions Above Timberline (BLUE)

The alpine areas with adequate vegetal cover are suitable for seasonal grazing by wildlife and domestic livestock. Water yield from the snowpack is important for this area. Recreation (backpacking, skiing, etc.) is also an important use.

The alpine plant association occurs above the timberline at elevations about 11,500 feet (3,505 m). The growing season at this elevation is short and the climate, even in summer, is severe. Vegetative production is meager and the plant communities are fragile, exhibiting extremely slow recuperation rates following disturbance. The species usually found in the alpine meadow are sedges, tufted hairgrass, bluegrasses, spike trisetum, alpine timothy, willows, bistort, bluebells, gentian, clovers, and kobresia.

Alpine barren areas include those alpine areas on which there is no natural vegetation, or practically none including shale, rock slides, snow fields, and glaciers.



Grassland and Meadows of Alpine Regions above Timberline.

B. Forest (GREEN, ORANGE, LIGHT GREEN AND YELLOW)

The importance of the forests for wood, recreation, forage for domestic livestock and wildlife, water, and other values is substantial.

The forested acreage is expected to remain fairly constant. Multiple use management of the forested lands will intensify in the future. Agriculture, urban development, construction of roads, reservoirs, power lines, recreation areas, and other uses are expected to cause the slight reduction of forest acreage. Because of lower elevations, gentler slopes, and better accessibility, the Ponderosa pine type is especially susceptible to reduction as a result of urban development.

Forests of the Rio Grande Basin include a number of major timber types. Distribution of the various species is influenced by elevation, precipitation, direction of slope and characteristics, length of growing season and other factors.

Pinyon-juniper trees grow at the lowest elevation on areas receiving from 10 to 14 inches (0.25 to 0.36 m) of precipitation a year. Above the 14-inch (0.36 m) precipitation zone, the general progression of species is (1) Ponderosa pine, (2) aspen, Douglas-fir, (3) subalpine fir and Englemann spruce.

The commercial forest area is distributed among four major forest types--Douglas fir, Ponderosa pine, spruce-fir, and aspen. The spruce-fir and aspen types grow at high elevations where lands are largely national forest. The ponderosa pine type which grows at relatively low elevations shows a somewhat higher proportion of private-state and other public ownership. Much of the winter range for elk and deer is in this forest type.

Although juniper and pinyon are used for fuel, Christmas trees, and fence posts, they are of low product demand and this results in low price.

The following generalized plant communities are self-descriptive by their names and reflect the general appearance of the various areas.

1. Forest and Grasslands of Sub-Alpine Areas (GREEN)

This area is limited at high elevations by severity of climate and at lower elevations by insufficient precipitation and high temperatures. Higher elevations support

sub-alpine areas dominated by spruce-fir, aspen and lodgepole pine with a sparse understory of sedges, grasses and low shrubs.

Forest and Grasslands of Sub-alpine Areas.

a. SPRUCE-FIR

Physical Characteristics

(1) Physiographic Features: This species association will generally occur in elevations between 9,000 and 11,500 feet (2,743 and 3,505 m) above sea level; above the lodgepole pine type and below the alpine types. Canyon bottoms and toe slopes are favored sites. Flat mesa tops with deep soils are also favorable.

(2) Climatic Features: Annual precipitation will range from 25 to 35 inches (0.64 to 0.89 m) with average annual temperature of 30 - 50° F. (-1.1 to 1.7° C) and a frost-free period of 0-60 days. (July mean temperature of about 55° F. [12.8° C]).

(3) Native Vegetation: This type is a woodland plant community. The Engelmann spruce and subalpine fir constitute a tree association. Each species may be dominant in small areas, but, in general, both species are present. In the lower limits, quaking aspen, lodgepole pine, and Douglas-fir may be associated; in addition, limber pine and bristlecone pine can be constituants of the stands.

(4) Associated Understory Plants: Fendlers bluegrass, spike trisetum, nodding brome, elk sedge, russet buffalo berry, dwarf blueberry, alpine willows, alder, mountain birch, ceanothus, boxleaf myrtle, currant-rose, and common juniper.

Grazing Use: There is little or no grazing value under the dense cover, regardless of the age of the stands. The grazing is limited to openings and parks adjacent to the timber stands. Season of use is the same as Subalpine Loam range site.

Society of American Foresters Cover Type 206. 1/

b. ASPEN

Physical Characteristics

(1) Physiographic Features: This species will generally occur in elevations between 7,000 and 11,500 (2,134 and 3,505 m) (San Luis Valley 8,000 to 11,500 [2,438 to 3,505 m] feet above sea level. This forest type can occur in any of the forest zones above the pinyon-juniper zone.

1/ Forest Cover Types of North America (Exclusive of Mexico), Society of American Foresters, 1973.

(2) Climatic Features: Annual precipitation averages from 18 to 30 inches (0.46 to 0.76 m), with the average annual temperature of 32 to 45° F. (0 to 7.2° C) and a frost-free period of 0 to 60 days.

(3) Native Vegetation: This type is a woodland plant community. Typically, it occurs in pure stands, but where transition is taking place, Douglas-fir, Engelmann spruce, subalpine fir, limber pine, bristlecone pine, or white fir may be a component of this type.

(4) Associated Understory Plants: The grasses, forbs and shrubs of the understory in Quaking Aspen woodlands include a diverse group controlled by soils and climatic factors.

Grasses are commonly subdominant to tall forbs but in some aspen communities grasses comprise a high percentage of the production and cover. The most abundant species include bearded wheatgrass, blue wildrye, mountain bromegrass, slender wheatgrass, Parry oatgrass, Thurber fescue, Arizona fescue and Idaho fescue. Grasses forming moderately abundant amounts but having fairly high occurrence rates are blue wildrye, nodding brome, oniongrass, Letterman needlegrass, Columbia needlegrass, elk sedge and mountain muhly.

Forbs dominate the understory in many aspen stands. Among the principal forbs are cow parsnip, wild celery (*Ligusticum)*, and sweet anise. Other common forbs are columbine, larkspur, monkshood, aspen fleabane (*Erigeron)*, butterweed groundsel, tall bluebells, meadow rue, gianthyssop (*Agastache)*, orange sneezeweed, green gentian, valerian, and western coneflower. Forbs generally lower in height than the ones listed above are aspen peavine, heart-leaf arnica, yarrow, lupine, geranium, golden pea, cinquefoil (*Potentilla)*, bedstraw, starwort, timber poisonvetch and American vetch.

Shrubs that are most often growing in the aspen understory include snowberry, serviceberry, chokecherry, rose, silver sagebrush and shrubby cinquefoil.

Common plants that occur on disturbed aspen sites are dandelion, wooly mullein, tarweed, rabbitbrush, big sagebrush, knotweed, Kentucky bluegrass and many other introduced plants and invaders.

Society of American Foresters Cover Type 217. 1/

c. LODGEPOLE PINE

Physical Characteristics

(1) Physiographic Features: This species will generally occur in elevations between 8,500 - 10,000 feet (2,591 to 3,048 m) above sea level, most often above the Ponderosa pine type and below the Spruce-fir type.

(2) Climatic Features: Annual precipitation averages above 20 inches (0.51 m) with the average annual temperature of 33 to 43° F. (0.56 to 6.1° C) and a frost-free period of 0-75 days.

(3) Native Vegetation: This type is a woodland plant community. Typically, it occurs in pure, dense stands. In the lower ranges, Douglas-fir and at the higher elevations, Engelmann spruce and subalpine fir may compose part of the overstory. Quaking aspen may be associated with it throughout its range.

(4) Associated Understory Plants: Spike trisetum, nodding brome, shrubby cinquefoil, Oregon grape, elk sedge, boxleaf myrtle, strawberry, Arizona fescue, Junegrass, nitmuhly, and common juniper.

Grazing Use: In dense stands, there is no grazing. Older stands have very little grazing value, except in parks and openings in the forest canopy.

Society of American Foresters Cover Type 218. 1/

d. SHALLOW SUBALPINE

Physical Characteristics

(1) Physiographic Features: Landscape characteristics are those of ridge tops, steep mountainous slopes and the edges of high mesas where parent rock is intermittently exposed.

The elevation is principally between 9,000 and 11,500 feet (2,743 and 3,505 m).

(2) Climatic Features: The average annual precipitation is 18 inches (0.46 m) or more with snow providing over 50% of the total. Most plant growth is made between June 1 and August 1. Although the frost-free period is short, production under grazing management can be high.

(3) Native (potential) Vegetation: This plant community is formed by a mixture of shrubs and forbs interspersed within a grassland that is interrupted by rock outcrops. The main grasses are Letterman and Columbia needlegrasses, nodding brome, mountain brome, slender wheatgrass, western wheatgrass, mountain muhly, muttongrass, Arizona/ Idaho and Thurber fescue, alpine timothy, blue wildrye, Parry oatgrass, spike trisetum, purple reedgrass and Junegrass. Some of the more frequent and conspicuous forbs in the community are ligusticum, larkspur, geranium, lupine, American vetch, paintbrush, hairy goldaster, penstemon aspen fleabane, sulfur buckwheat and rose pussytoes. Silver sagebrush, mountain big sagebrush, gooseberry, fringed sage, shrubby cinquetoil, and currant are common shrubs. The site itself is treeless but is in the aspen, spruce-fir zone. Ground cover (not counting the areas of bare rock) approximates 30 percent.

Plants not a part of the potential plant community that are most likely to invade when the cover deteriorates are blue grama, slimstem muhly, Colorado rubberweed, snakeweed and introduced species.

Range Site No. 251. 2/

2/ Colorado Soil Conservation Service Technical Guide, Section II-E.

e. SUBALPINE LOAM

Physical Characteristics

(1) Physiographic Features: This site takes in mountain parks and other open grassland, generally within the spruce-fir zone. In some places it is interspersed with aspen groves. Topography is mostly rolling, with gentle to moderate slopes, but some areas are steep.

Slopes range up to about 40%, but are between 6 and 25% on much of the site. Slope is not a determining factor within the site itself, although it has had some effect on vegetation. It may be as high as 10,000 feet (3,048 m) in the drier southern mountains. Upper elevations is about that of timberline--11,500 feet (3,505 m) over much of the state and up to 11,800 feet (3,597 m) in some southern portions.

(2) Climatic Features: Average annual precipitation is at least 20 inches (0.51 m) and may be much higher. At least 60% of the moisture falls as snow. June is a dry month on much of the site, but in near-normal years, soil moisture from snowmelt carries over until summer rains begin. Light afternoon showers are frequent through mid and late summer. The optimum growing season of major native plants is early June to late July. The mean annual temperature ranges between about 30 - 40° F. (-1.1 to 4.4° C). Average frost-free period is generally 50 days or less.

Evaporation rates are relatively low. The ground is well covered by snow during coldest weather and snowmelt is relatively late. The typical plant community seems to be associated with depth and duration of snow pack. It is absent from some areas where winds commonly blow off a large amount of snow, even though elevation, general soil characteristics, and total precipitation seem to be right for it.

(3) Native (potential) Vegetation: Large bunchgrasses give the site a lush grassland aspect. Thurber fescue is always present and usually dominant. Parry oatgrass is co-dominant in some places, but is scarce or absent in other localities. Arizona fescue shows up on lower

transitional areas in the southern part of the state. Slender wheatgrass, nodding brome, and Columbia and Letterman needlegrasses are common secondary grasses. Small amounts of squirreltail, Junegrass and elk sedge are usually present. Others which may occur in minor amounts are bearded wheatgrass, onion grass, spike trisetum, western wheatgrass, mountain brome, sheep fescue, and mountain muhly. Forbs are showy when in bloom and may make up as much as 20% of the annual yield. Among the most common forbs are aspen fleabane, trailing fleabane, aspen peavine, American vetch, Porter ligusticum, pale paintbrush, lupine, geranium, penstemon, yarrow, herbaceous sage, meadow rue, showy cinquefoil, mules-ear wyethia, eriogonum, and native clovers. Orange sneezeweed or fernleaf pedicularis show up in places. There may be small amounts of mountain dandelion, loco, hawksbeard, harebell, iris, phlox, tall larkspur, tuber starwort, Gunnison lily, Douglas clematis, sweet anise, mountain sunflower, showy goldeneye and several others. Shrubs are of minor importance, although a few of them are usually scattered over the site. Snowberry is a common shrub. Small amounts of fringed sage, shrubby cinquefoil, rose, alder, chokecherry, or serviceberry may occur.

Tree species commonly associated with the site and often seen on small inclusions are Engelmann spruce and aspen. Approximate ground cover is 50 percent.

Species most likely to invade the site or increase from trace amounts are Kentucky bluegrass, dandelion, Douglas knotweed, Douglas rabbitbrush, pussytoes, and annual forbs. In some places aspen may invade.

As the ecological condition deteriorates, Thurber fescue and most associated grasses decline and some may eventually disappear. Some of the invaders listed above then become prominent, and there may be substantial increases in lupine, orange sneezeweed, cinquefoils, yarrow, mules-ear wyethia, trailing fleabane, fringed sage, or snowberry. Kentucky bluegrass, Letterman needlegrass, or sheep

fescue usually become the main grasses as deterioration continues. (Under sheep use, Thurber fescue may hold its own or increase for a time while many forbs decrease.)

Range Site No. 250. 2/

Forest of Lower Mountains

2. Forest of Lower Mountains (ORANGE)

This area is characterized by stands of Ponderosa pine with Douglas-fir, blue spruce, white fir and occasional aspen mixed with fescue, muhly, bluegrass, shrubs and forbs.

a. PONDEROSA PINE

Physical Characteristics

(1) Physiographic Features: This forest type occurs at elevations from 8,000 to 9,000 feet (2,438 to 2,743 m) above sea level, generally above the pinyon-juniper woodland, but below the lodgepole or the spruce-fir forests.

(2) Climatic Features: Annual precipitation averages above 16 inches (0.4 m) with an average annual temperature of 33 to 43° F. (0.56 to 6.1° C) and a frost-free period of 30 to 100 days.

(3) Native Vegetation: This type is a woodland plant community. Typically, this species occurs in pure stands, but at the upper elevations, it may contain Douglas-fir, white fir, limber pine, or quaking aspen; and at lower limits, it may also contain pinyon pine and Rocky Mountain juniper.

(4) Associated Understory Plants: Ponderosa pine understory vegetation in Southwestern Colorado resembles the Arizona-New Mexico woodlands. Plant communities associated with Ponderosa pine, have therefore, an interesting collection of diverse species.

Two grasses are common throughout the Ponderosa pine zone. They are Arizona fescue and mountain muhly. In addition to these dominants several other grasses grow in moderate to sparse abundance. Common among these are Parry oatgrass, pine dropseed, muttongrass, Indian ricegrass, western wheatgrass, blue grama, little bluestem, prairie sandreed, needlegrasses, sedges, Junegrass and big bluestem.

Forbs occur in minor amounts as measured by percentage of ground covered or total yield. Frequent forbs growing in the understory are pussytoes, yarrow, wildbuckwheat (*Eriogonum*), geranium, golden pea, penstemon, groundsel, peavine, hairy goldaster, pasqueflower and cinquefoil (*Potentilla*).

Shrubby species to be expected in Ponderosa pine understories include bearberry (*Kinnikinnick*),

rose, juniper, Fendler bush, snowberry, bitterbrush, deer brush, squawapple and Gambel oak.

Introduced plants that invade Ponderosa pine understories include cheatgrass, wooly mullein, dandelion, sleepygrass, snakeweed, rabbitbrush, pinque, toadflax, Russian knapweed and others.

Society of American Forest Cover Type 237. 1/

b. DOUGLAS-FIR

Physical Characteristics

(1) Physiographic Features: This species will generally occur in Colorado at elevations from 7,500 to 9,000 (2,286 to 2,743 m) - (San Luis Valley 8,500 to 9,500 feet [2,591 to 2,896 m]) above sea level. This forest type prefers north and east facing aspects.

(2) Climatic Features: Annual precipitation averages 18 to 24 inches (0.46 to 0.61 m) with an average annual temperature of 37 to 42° F. (2,8 to 5.6° C) and a frost-free period of 30 to 60 days.

(3) Native Vegetation: This type is a woodland plant community. At lower elevations it is associated with Ponderosa pine, white fir, and aspen. In the upper elevations, it is associated with Engelmann spruce, subalpine fir, and aspen. Limber pine and blue spruce may also be present.

(4) Associated Understory Plants: Kinnikinick, boxleaf myrtle, common juniper, oregon grape, Gambel oak, snowberry, mountain muhly, Arizona fescue, Thurbers fescue, elk sedge, Fendlers bluegrass, and squirreltail.

Grazing Use: Generally, the only significant grazing is found in the older stands, in openings, or in parks in this type. Season of use is the same as for Mountain Loam range site.

Society of American Foresters Cover Type 210. 1/

3. Pinyon-Juniper Type (LIGHT GREEN)

This area is characterized by pinyon and/or juniper with wheatgrass, Indian rice, bluegrass mixed with shrubs and forbs.

Pinyon-Juniper

a. PINYON-JUNIPER

Physical Characteristics

(1) Physiographic Features: This woodland association generally occurs in the San Luis Valley at elevations between 8,000 to 9,000 feet (2,438 to 2,743 m) above sea level. This is generally the first woodland type above the natural grasslands.

(2) Climatic Features: Annual precipitation averages from 12 to 15 inches (0.3 to 0.38 m) with an average annual temperature of 49 to 53° F. (9.4 to 11.6° C) and frost-free period of 60 to 120 days.

(3) Native Vegetation: The pinyon-juniper woodland type is a tree plant association and occurs at the lowest elevations of any of the woodlands. In the middle of the range, a mixture of the pinyon pine and juniper occurs and at the upper slopes of this type, pinyon pine tends to become the dominant species of the stand.

(4) Associated Understory Plants: With the wide distribution of the Pinyon-Juniper woodland in Colorado there are major variations in the kinds of plants in the potential plant community.

Grasses in the understory are often the dominant species. Those commonly growing in abundance at different locations include Indian ricegrass, blue grama, muttongrass, western wheatgrass, and scribner needlegrass.

Grasses growing in less abundance or in subdominant positions include needle-and-thread, Junegrass, squirreltail, sand dropseed, sedges, mountain muhly, three-awn, Sandberg bluegrass and slimstem muhly.

Grasses that form only a sparse cover or are seen as occasional members of the understory are littleseed ricegrass, and Salina wildrye.

A number of forbs grow in the Pinyon-Juniper woodland but few of them ever become especially dominant or very abundant. Some of the most frequently seen forbs are rock goldenrod, wild-buckwheats (*Eriogonum*), hairy goldaster, globe mallow, loco, milkvetch, phlox, penstemon, gilia, goldenweeds, bladderpods, lupine, cryptantha, pinque (*Hymenoxys*), fleabane (*Erigeron*), golden-eye, Colorado four-o'clock, Indian paintbrush and pussytoes.

Society of American Foresters Cover Type 239. 1/

4. Grasslands and Brushlands of High Mountain Parks and Basins (YELLOW)

   This area contains a transition type between Forest and other vegetation types. It is comprised of unbroken expanses of grass to scattered, pinyon and/or juniper. For additional information refer to the following RANGE section.

C. Range (YELLOW and PURPLE)

Rangeland in the basin is used for forage production, for wildlife and domestic livestock, recreation and natural beauty, and watershed.

The following generalized plant communities are self-descriptive by their names and reflect the general appearance of the various areas.

1. Grassland and Brushlands of High Mountain Parks and Basins (YELLOW)

   In this area the vegetation varies from unbroken expanses of grasses to scattered pinyon and/or juniper to areas of big sagebrush, rabbitbrush and winterfat. Range sites for this area are as follows:

Grassland and Brushland of High Mountain Parks and Basins

a. BASALT HILLS

Physical Characteristics

(1) Physiographic Features: This site occupies low hills, mesas, ridges, escarpments, and broken land formed by lava flows. Topography is mostly rough, but varies from gentle slopes to steep cliffs. Rock outcrops are common.

Slopes are quite variable, averaging between 3% and 35%. Vegetation is favored by shading and lower evaporative losses on northerly-facing slopes. In places, certain species are restricted to these slopes or to small pockets where rain and snow collect. Elevation is mostly 7,800 to 8,600 feet (2,377 to 2,621 m), extending slightly higher in a few places.

(2) Climatic Features: Average annual precipitation is 7 to 10 inches (0.18 to 0.25 m). Of this, 55% to 60% falls between May 1 and September 1, mostly from hard, spotty thundershowers in July and August. May and June are normally dry. Wide seasonal and yearly variations are common. Major native plants make most of their growth between early May and late July, although growth may extend into September. Some plants normally complete growth by mid-June and may make late re-growth.

Mean annual temperature is 42° to 43° F. (5.6 to 6.1° C). Average frost-free period is 95 to 105 days, from late May or early June to September. Summer daytime temperatures are frequently in the 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Winter temperatures of -20° to -30° F. (-29° C to -34° C) can be expected every year and are common some years. Lower extremes have been recorded.

Winds that often reach high velocities are common, especially in spring, although broken topography may reduce wind effects to some degree. Relative humidity is usually low. Even so, evaporation rates average lower than those of many dry regions because of the cooler climate. Snow cover is often light and is sometimes only patchy through much of the winter. There is usually some snow, though, during the coldest weather.

(3) Native (potential) Vegetation: Plant spacing is rather wide, but cover is fairly uniform except for bare outcrops. Climax cover is mostly grasses with a scattering of forbs and shrubs. Indian ricegrass is the major grass. Others are blue grama, squirreltail, sand dropseed, spike dropseed, Fendler three-awn, needle-and-thread, Scribner needlegrass, and western wheatgrass. Colorado four-o'clock is the most prominent forb. There are small amounts of several others. Fourwing saltbush, winterfat, prickly pear and yucca are usually present. There are commonly trace amounts of other shrubs, including gooseberry, skunkbush sumac, rubber rabbitbrush, fringed sage, hedgehog cactus; and, in places, Apache plume and Bigelow sagebrush. It shows up in a few other places on northerly-facing slopes and drainageways, but is absent over much of the site. Widely scattered, stunted juniper and pinyon show up in a few places.

Tree species are one-seed juniper and pinyon pine. Approximate ground cover is 15%.

Species most likely to invade the site are annual forbs (Russian thistle, tumbling mustard, etc.). As the ecological condition declines, grasses decrease drastically and may consist mostly of patchy blue grama and three-awn. Green's rabbitbrush or big sagebrush (where natural) and prickly pear usually become dominant, along with invading annuals. Advanced deterioration leads to mostly prickly pear and bare ground (or annuals in favorable years).

Range Site No. 277. 2/

b. FOOTHILLS

Physical Characteristics

(1) Physiographic Features: The site occupies smooth or rolling land on alluvial fans and footslopes, narrow valleys, and mesa tops. It is usually associated with pinyon-juniper land. Slopes range from 0 to 25%, but are mostly between 1 and 9%, and are not significant to plant growth. Elevation is about 8,200 to 9,000 feet (2,499 to 2,743 m).

(2) Climatic Features: Average annual precipitation is 12 to 14 inches (0.3 to 0.36 m). Of this, more than half falls between May and September 1, mostly as hard, spotty thundershowers in July and August. May and June are normally dry. Wide seasonal and yearly variations are common. Snow makes up a slightly higher percent of the total than on some nearby sites at lower elevations. Major plants make most of their growth between early May and late July, sometimes extending it through most of August. Some plants normally complete growth by mid-June and may make late regrowth.

Mean annual temperature is 40° to 43° F. (4.4 to 6.1° C). Average frost-free period is 80 to 105 days, from late May or early June to September. Summer daytime temperatures are frequently in the low 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Temperatures of -20° to -30° F. (-28.9° to -34.4° C) can be expected each year and are common some winters. Parts of this site, though, are slightly warmer than lower valley land because of air drainage. Winds that often reach high velocity are common, especially in spring. Relative humidity is often low. Even so, evaporation rates average lower than those of many dry regions because of the cooler climate. There is usually more snow than at lower elevations, and snow is usually present during the coldest weather. However, snow cover is light or patchy through much of some winters.

(3) Native (potential) Vegetation: This is principally a grassland site with a scattering of big sagebrush. The main grass is western wheatgrass. Others commonly present are needle-and-thread, muttongrass, Indian ricegrass, Junegrass, blue grama, and squirreltail. Minor amounts of a number of forbs and shrubs can be expected. Among them are Eriogonum, paintbrush, penstemon, lupine, loco, fringed sage, Douglas rabbitbrush, Green's rabbitbrush, fourwing saltbush, and winterfat.

Trees are not natural to the site in more than trace amounts. Pinyon pine, one-seed juniper, or Rocky Mountain juniper have invaded in places. Approximate ground cover is 35%.

Species most likely to invade the site are introduced annual forbs, pinyon and juniper, and sleepygrass. The latter is most common on old fields. Others which may increase substantially from trace amounts are rubber rabbitbrush, snakeweed, prickly pear, Colorado rubberweed, and ring muhly. A decrease in grasses and strong dominance by big sagebrush is a common feature of ecological deterioration. Blue grama often becomes the main grass, and it, too, becomes sparse under prolonged heavy grazing.

Range Site No. 283. 2/

c. FOOTHILL LOAM

Physical Characteristics

(1) Physiographic Features: This site occupies gently to moderately sloping fans and valleys in the pinyon-juniper zone. Much of it is in position to receive water that runs off steeper land. Most of it is dry, though, except temporarily. A few spots are grading toward meadow sites. The site may tongue out below its normal elevation where there is occasional overflow. Slopes are mostly 0 to 6%, although some are steeper. Slope is not significant to plant growth. Elevations are about 8,000 to 8,500 feet (2,438 to 2,591 m).

(2) Climatic Features: Average annual precipitation is 10 to 14 inches (0.25 to 0.36 m). Of this, more than half falls between May 1 and September 1, mostly as hard, spotty, thundershowers in July and August. May and June are normally dry. Wide seasonal and yearly variations are common. Major native plants make most of their growth between early May and mid-July, although growth may continue through most of the summer, and there may be late regrowth of some early-maturing plants.

Mean annual temperature is 40° to 43° F. (4.4 to 6.1° C). Average frost-free period is 80 to 103 days, from late May to early June to September. Summer daytime temperatures are frequently in the low 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Temperatures of -20° to -30° F. (-28.9 to -34.4° C) can be expected each year and are common some winters. Parts of the site are

slightly warmer, though than lower valley land because of air drainage. Winds that often reach high velocities are common, especially in spring. Relative humidity is often low. Even so, evaporation rates average lower than those of many dry regions because of the cooler climate. There is usually more snow than at lower elevations, and snow is usually present during the coldest weather. However, snow cover is light through much of some winters.

(3) Native (potential) Vegetation: This is primarily a grassland site. Western wheatgrass is the major grass. Others commonly present are needle-and-thread, sedges, Indian ricegrass, and blue grama. There may be small amounts of slender wheatgrass, Scribner needlegrass, muttongrass, Junegrass, squirreltail, sand dropseed, mountain muhly, and Arizona fescue. Forbs are minor. Eriogonum, loco, and lupine are the most prevalent. Of the scattered shrubs, four-wing saltbush and rubber rabbitbrush are most common. Others are currant, gooseberry, Green's and Douglas rabbitbrush, winterfat, and skunkbush sumac. A few pinyon trees or other conifers are present on parts of the site, but are not a significant part of the plant community.

Tree species (very minor if present) are pinyon pine, one-seed and Rocky Mountain juniper, ponderosa pine, and Douglas-fir. Approximate ground cover is 30%. Species most likely to invade the site are sleepygrass (especially on old fields), and annual introduced forbs. With ecological deterioration, some species which may increase from trace amounts are Green's rabbitbrush, fringed sage, snakeweed, and prickly pear. The most common feature of ecological decline is dominance by rubber rabbitbrush and drastic decrease in grasses--except blue grama, initially, (and eventually it, too). Rubber rabbitbrush has completely taken over some locations.

Range Site No. 317. 2/

d. FOOTHILL SAND

Physical Characteristics

(1) Physiographic Features: This site occurs on the east side of the San Luis Valley on gentle to moderately steep fans and slopes just below the steeper pinyon-covered lands. Most of it is dissected by many narrow intermittent drainageways. Elevation ranges from 8,000 to 8,500 feet (2,438 to 2,591 m).

(2) Climatic Features: Average annual precipitation varies from 9 (0.23 m) to about 12 inches (0.3 m) with over 50% falling between May and October. July and August generally receive the most moisture, often coming as hard fast rains. June is usually the driest month. Mean annual temperature is about 45 degrees (7.2^{o} C). The optimum growing season for major native plants is May 15 to September 1.

(3) Native (potential) Vegetation: A rather open and patchy growth of pinyon pine and juniper mixed with a scattered growth of grasses and shrubs characterizes the site. Major grasses include Scribner needlegrass, needle and thread, Indian ricegrass, Western and thickspike wheatgrass, June grass and blue grama. Other common grasses are sand dropseed, squirreltail, blowout grass, mutton grass, littleseed ricegrass, and (in favorable locations) mountain muhly and Arizona fescue in minor amounts. Forbs such as buckwheat, paintbrush, pentstemon, goldaster, lupine, golden pea, scarlet gilia, locos, and pingue occur in small amounts, but are conspicuous when in bloom. Dominant shrubs are mountain mahogany, skunkbrush, wax currant, gooseberry, tall rabbitbrush, snowberry, and serviceberry. Trace amounts of four-wing saltbush, winterfat, horsebrush, yucca, prickly pear, and rock spirea are usually present.

Tree species are pinyon pine, one-seed juniper, and Rocky Mountain juniper. Approximate ground cover is 30%.

Species most likely to invade this site or increase drastically from the amounts shown above are blue grama, sand dropseed, threeawn, slimstem and sandhills muhly, snakeweed,

pingue, rabbitbrush, yucca, prickly pear cactus, and annuals.

Range Site No. 279. 2/

e. ROCKY FOOTHILLS

Physical Characteristics

(1) Physiographic Features: This site may occur on gentle slopes but is most common on steep, broken land, especially the lower slopes of steep mountain ranges. It is usually dissected by arroyos and small canyons. Slopes range from 3 to 25% and are quite variable. Vegetation is facing slopes. In the driest areas the site may be confined to long, northerly-facing slopes. In other places this site is on dry southerly exposures, the opposite slopes being woodland. Elevation is 8,000 to about 9,000 (2,438 to 2,743 m) feet.

(2) Climatic Features: Average annual precipitation is 9 to 12 inches (0.23 to 0.3 m). Of this, 55% to 60% falls between May 1 and September 1, mostly from hard, spotty thundershowers in July and August. May and June are commonly dry. Wide seasonal and yearly variations are common. Major native plants make most of their growth between early May and late July, sometimes extending it through most of August. Some plants normally complete growth by mid-June and may make late regrowth.

Mean annual temperature is 40° to 43° F. (4.4 to 6.1° C). Average frost-free period is 80 to 105 days, from late May or early June to September. Summer daytime temperatures are frequently in the low 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Temperatures of -20° to -30° F. (-28.9 to -34.4° C) can be expected each winter and are common some years. Parts of this site are slightly warmer than lower valley land because of air drainage. Winds that often reach high velocities are common, especially in spring, although broken topography may reduce wind effects to some degree. Relative humidity is often low. Even so, evaporation rates average

lower than those of many dry regions because of the cooler climate. There is more snow than at lower elevations, and snow is usually present during the coldest weather. However, it is only patchy on south slopes and exposed areas through much of some winters.

(3) Native (potential) Vegetation: A rather open or patchy growth of pinyon pine and juniper (mostly pinyon) mixed with a patchy stand of grasses and shrubs characterizes the site. Major grasses include western wheatgrass, needle-and-thread, Scribner needlegrass, Indian ricegrass, and blue grama. Also common are muttongrass, Junegrass, squirreltail, little-seed ricegrass, and (in favored locations) mountain muhly and small amounts of Arizona fescue. Forbs make up a small part of the yield, but some are conspicuous when in bloom. They include Eriogonum, paintbrush, penstemon, hairy goldaster, Colorado rubberweed, lupine, scarlet gilia, and locos. Important shrubs are true mountain mahogany, wax currant, gooseberry, and Douglas rabbitbrush. Serviceberry, skunk-bush sumac, snowberry, fringed sage, fourwing saltbush, winterfat, prickly pear, and yucca are commonly present, and there may be some James cliffbush and rock spirea.

Tree species are pinyon pine, one-seed juniper, and Rocky Mountain juniper. Approximate ground cover is 25%. Species most likely to invade are annual forbs such as Russian thistle. Others which may increase substantially from trace amounts are snakeweed, rubber rabbit-brush, ring muhly, and Colorado rubberweed. As the ecological condition deteriorates, the above plants often become prominent, along with hairy goldaster and large amounts of prickly pear. Grasses may decline to an extremely patchy growth of blue grama. Pinyon or juniper may increase substantially.

Range Site No. 286. 2/

f. VALLEY BENCH

Physical Characteristics

(1) Physiographic Features: Topography varies from nearly level to moderately rolling. The site is on broad outwash fans and alluvial valleys, mainly along the southeast edge of the San Luis Valley and drier portions of adjoining stream valleys. It lies just below the pinyon-juniper foothills.

Slopes are mostly between 0 and 3%, ranging up to 9% in a few places, and are not significant to plant growth. Elevation is about 7,800 to 8,200 feet (2,377 to 2,499 m)-(slightly higher in a few places).

(2) Climatic Features: Average annual precipitation is 10 to 12 inches (0.25 to 0.3 m). Of this, 55% to 60% falls between May 1 and September 1, mostly as hard, spotty thundershowers in July and August. May and June are normally dry. Winter snow is light but makes up a slightly higher pecent of the total than in the San Luis Valley proper. Wide seasonal and yearly variations are common.

Major native plants make most of their growth between early May and late July, sometimes extending it through most of August. Some plants normally complete growth by mid-June and may make late growth.

Mean annual temperature is 41° to 43° F. (5 to 6.1° C). Average frost-free period is 90 to 100 days, from late May or early June to September. Summer daytime temperatures are frequently in the 80's (26.7° C) but rarely exceed 90° F. (32.2° C) and nights are cool. Temperatures of -20° to -30° F. (-28.9 to -34.4° C) can be expected each year and are common some winters. Winds that often reach high velocities are common, especially in spring. Relative humidity is often low. Even so, evaporation rates average lower than those of many dry regions because of the cooler climate.

Snow is usually present during the coldest weather. However, snow cover is light or patchy during much of some winters.

(3) Native (potential) Vegetation: This is mainly a grassland site, with big sagebrush and other shrubs making up about 20% of the annual yield. Major grasses are western wheatgrass, needle-and-thread, and blue grama. Indian ricegrass, squirreltail, needleleaf sedge and sand dropseed are usually present, and there may be small amounts of several other grasses. Forbs make up 5 to 10 percent of the total. Some of the main ones are eriogonum, lupine, locos and milkvetches, scarlet globemallow, and penstemon. Big sagebrush is the main shrub. Minor amounts of fourwing saltbush, winterfat, Green's rabbitbrush, and fringed sage can be expected, along with traces of prickly pear and yucca. The stand is uniform, the grasses filling in between brushy plants.

There are no tree species natural to the site. Approximate ground cover is 30%. Species most likely to invade the site or increase from trace amounts are introduced annual forbs, Colorado rubberweed, snakeweed, wormweed, rubber rabbitbrush, and ring muhly.

The above plants commonly show up as the ecological condition deteriorates, but the most striking feature is usually a strong dominance by big sagebrush. With the sagebrush may be a great deal of Green's rabbitbrush and prickly pear. Grass cover often becomes mostly stunted, patchy blue grama and may nearly disappear.

Range Site No. 278. 2/

2. "Chico Land" of the San Luis Valley (PURPLE)

The vegetation in this area consists of greasewood, rabbitbrush, fourwing saltbrush, saltgrass, alkali sacaton, wheatgrass, sedges and rushes.

Range sites for this area are as follows:

"Chico Land" of the San Luis Valley

a. ALKALI OVERFLOW

Physical Characteristics

(1) Physiographic Features: This site is flat or basin-like. It exists on the lower reaches of poorly defined drainage courses with no outlets and around the edges of shallow, land-locked lakebeds. The site is subject to overflow, but may go for long periods without the benefit of any runoff. Elevation ranges from 7,500 to 7,600 feet (2,286 to 2,316 m).

(2) Climatic Features: Annual precipitation averages 6 to 8 inches (0.15 to 0.2 m), 55 to 60% falling from May through September. Hard rains are common during July and August. May and June are normally dry. The mean annual temperature is about 42 degrees (5.5° C), with a frost-free period of 75 to 90 days. Evaporation rate is low except during periods of high winds. The optimum growing season for major native plants is about May 1 to August 15.

(3) Native (potential) Vegetation: Plants adapted to severe saline-alkali conditions and prolonged periods of either drought or complete inundations occupy most of the site. The dominant grasses are saltgrass, baltic rush, spike rush, creeping wildrye, and western wheatgrass. Minor amounts of alkali sacaton, alkali cordgrass, alkali bluegrass, and alkali grass may also be present. Greasewood and fourwing saltbush are the only shrubs to be found on the site, and these are subject to loss during periods of prolonged flooding. Samphire, Kochia, seepweed, Iodine bush, and bull rush are the dominant forbs and grass-like plants, and will occur only in trace amounts. Low areas more subject to flooding will be void of any vegetation.

Range Site No. 314. 2/

b. DEEP SAND

Physical Characteristics

(1) Physiographic Features: This site represents the stabilized lands adjacent to the Sand Dunes National Monument on the east side of the San Luis Valley. The topography consists of gently rolling vegetated dunes and blow-outs. Elevation ranges from about 7,600 to 8,000 feet (2,316 to 2,438 m).

(2) Climatic Features: Precipitation averages 7 to 9 inches (0.18 to 0.23 m) annually, with about 50% falling between May 1 and October 1. July and August are the most favorable moisture months, while June is generally the driest. The mean annual temperature is about 45 degrees (7.2° C), with a frost-free period of about 90 days. Evaporation rate is low except during periods of strong winds. The optimum growing season for major native plants is May 15 to September 15.

(3) Native (potential) Vegetation: Indian ricegrass, needle-and-thread, western and thickspike wheatgrasses, creeping wildrye, blue grama, and blowout grass make up most of the ground cover. Plants such as sandhill muhly, sand dropseed, spike dropseed, prairie sandreed, squirreltail, scurfpea, sand verbena, winterfat, smooth horsebrush and fourwing saltbush are secondary in the plant community. Small amounts of ring ruhly, slimstem muhly, fendlers threeawn, prickly pear, low and tall rabbitbrush, yucca, snakeweed, groundsel, and bee plant may occur in scattered amounts.

Tree species are not a part of the natural plant community. Approximate ground cover is 30%.

Species most likely to invade the site are annual forbs such as sunflowers, Russian thistle, Kochia, lambsquarter, pepper grass, and tansy mustard. This is a rather fragile site; and as the ecological condition deteriorates, the major grasses give way to blue grama, threeawn, ring muhly, and sandhill muhly. There will also be an increase in the brush species mentioned above.

Range Site No. 275. 2/

c. LIMY BENCH

Physical Characteristics

(1) Physiographic Features: The site is typically on broad benches and fans above the valley floor on the west side of the valley. It has developed mostly on igneous outwash material, but overlies volcanic bedrock in a few places. Topography is nearly level to moderately rolling, with some areas forming broad plains. Slopes range up to 25%, but are generally less and are not significant to plant growth. Elevation is mostly 7,600 to 8,000 feet (2,316 to 2,438 m). The site extends up to 8,500 feet (2,591 m) in a few places.

(2) Climatic Features: Average annual precipitation is 7 to 10 inches (0.18 to 0.25 m). Of this, 55% to 60% falls between May 1 and September 1,

mostly from hard, spotty thundershowers of short duration in July and August. May and June are normally dry. Wide seasonal and yearly variations are common. Most major plants make their main growth between mid-May and late July, but growth may extend into September. Some of the main grasses start earlier and complete growth by mid-June. There may be late regrowth on some of these.

Mean annual temperature is 42° to 43° F. (5.6 to 6.1° C). Average frost-free period is 95 to 105 days, from late May or early June to September. Summer daytime temperatures are frequently in the 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Winter temperatures of 20 to 30 degrees (-28.9 to -34.4° C) below zero can be expected every year and are common some years. Lower extremes are sometimes recorded.

Winds that often reach high velocities are common, especially in spring. Relative humidity is usually low. Even so, evaporation rates average lower than those of many dry regions because of the cooler climate. Snow cover is often light and is sometimes lacking through much of the winter. There is usually some snow, though, during the coldest weather.

(3) Native (potential) Vegetation: Winterfat dominates the plant community and gives the site a distinctive appearance. Fourwing saltbush is usually present. Small amounts of Green's rabbitbrush and prickly pear are common. There may be scattered plants of fringed sage, snakeweed, rubber rabbitbrush, and yucca. Grasses are well distributed through the stand and make up nearly half the annual yield. Indian ricegrass, squirreltail, and blue grama are usually the main grasses. Western wheatgrass is common in places, and Fendler threeawn is usually present. Scarlet globemallow and other forbs are of minor importance.

Tree species are not a natural part of the plant community. Approximate ground cover is 25%. Species most likely to invade are annual forbs such as Russian thistle, sunflower, and golden crownbeard. As the ecological condition

declines, Indian ricegrass often disappears, and other main grasses become scarce. Blue grama holds its position longer than the other main grasses. Winterfat and fourwing saltbush become weakened and gradually give way to Green's rabbitbrush and rubber rabbitbrush. Blue grama may become prominent in a stage of recovery if winterfat has been severely thinned.

Range Site No. 276. 2/

d. MOUNTAIN OUTWASH

Physical Characteristics

(1) Physiographic Features: This site occupies broad alluvial fans formed by outwash from high mountain ranges. In many places, the fans have coalesced to form a smooth plain that feathers out to a flat valley floor. In some places, they form low benches or terraces above stream courses. There are some minor undulations caused by small drainageways, but most of the site has smooth topography and some is nearly level.

Slopes are mostly 0 to 3% and are not significant to plant growth. Elevation is 7,600 to about 8,000 feet (2,316 to 2,438 m).

(2) Climatic Features: Average annual precipitation is 7 to 9 inches (0.18 to 0.23 m). Of this, 55% to 60% falls between May 1 and September 1, mostly from hard, spotty thundershowers of short duration in July and August. May and June are normally dry. Wide seasonal and yearly variations are common.

Most major plants make their main growth between mid-May and late July, but growth may extend into September. Some of the main grasses start earlier and complete growth by mid-June. There may be late regrowth on some of these.

(3) Native (potential) Vegetation: A fairly uniform stand of grasses with a few low shrubs give the site a typically smooth appearance. Blue grama is usually the most abundant grass. But taller

grasses, mostly cool-season species, make up a significant part of the annual production. Of these, needle-and-thread, squirreltail, western wheatgrass, and Indian ricegrass are most important. There are usually small amounts of sand dropseed, Fendler three-awn, needleleaf sedge, and slimstem muhly, along with a few forbs such as scarlet globemallow, eriogonum, senecio, wall flower, loco, evening primrose, and paintbrush. Scattered shrubs include Green's rabbitbrush, an occasional low-growing form of rubber rabbitbrush, winterfat, and fourwing saltbush. Small amounts of prickly pear also occur and there may be some fringed sage, smooth horsebrush, snakeweed, and yucca.

Tree species are not in the natural plant community. Approximate ground cover is 30%.

Species most likely to invade the site are annual forbs such as lambsquarter, Kochia, Russian thistle, sunflower, tansy mustard, and pepperweed. Some of these may come in temporarily on well-vegetated range when spring and early summer moisture are above average. As the ecological condition deteriorates, the major grasses--except blue grama-- decrease sharply; and some eventually disappear. They give way to mixtures of blue grama, Green's and rubber rabbitbrush, snakeweed, and prickly pear. Such vegetation now characterizes most of the site. With advanced deterioration, ring muhly may make up much of the sparse grass cover, and blue grama breaks into weak, scattered plants. The above-mentioned shrubs, with annual forbs, are then dominant; and there is much bare ground.

Range Site No. 281. 1/

e. SALT FLATS

Physical Characteristics

(1) Physiographic Features: This is typical of the broad central floor of the San Luis Valley, and is also on a few small areas near the edge of the valley. Topography is nearly level over most of the site, gently sloping in a few places, with only minor irregularities. The site is slightly higher than associated meadows.

Slopes are mostly 0 to 1%, extending up to 3% in a few places, and have no significant effect on plant growth. Elevation is 7,500 to 7,700 feet (2,286 to 2,347 m) except for some isolated spots that are slightly higher.

(2) Climatic Features: Average annual precipitation is 6 to 8 inches (0.15 to 0.2 m), possibly reaching 10 inches at some upper elevations. Of this, 55 to 60% falls between May 1 and September 1, mostly from hard, spotty thundershowers of short duration in July and August. May and June are normally dry. Wide seasonal and yearly variations are common. Major plants make their main growth between mid-May and late July. A few plants are slightly earlier.

Mean annual temperature is 41° to 43° F. (5 to 6.1° C). Average frost-free period is 95 to 105 days, from late May or early June to September. Summer daytime temperatures are frequently in the 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Temperatures of -20° to -30° F. (-28.9 to -34.4° C) can be expected each year and are common some winters. Lower extremes are sometimes recorded. Winds that often reach high velocities are common, especially in spring. Relative humidity is usually low. Even so, evaporation rates average lower than those of many dry regions because of the cool climate. Snow cover is often light and is sometimes lacking through much of the winter. There is usually some snow though, during the coldest weather.

(3) Native (potential) Vegetation: Salt tolerant grasses mixed with greasewood and rubber rabbitbrush give the site its typical appearance. The shrubs are prominent but widely spaced. Alkali sacaton is usually the dominant plant, forming large clumps with small bare spots between them. Other grasses which may be locally abundant are alkali cordgrass, western wheatgrass and beardless wildrye. Blue grama is prominent on some soils, but is scarce or absent on much of the site. Minor amounts of saltgrass, wedgegrass, fourwing saltbush, and Baltic rush are common. Forbs are of minor

importance; some of the most prevalent are wild licorice, Rocky Mountain bee plant, wallflower and globemallow.

There are no tree species. Approximate ground cover is 30-40%. Species most likely to invade the site are annuals (Kochia, lambsquarter, Russian thistle, tansy mustard, pepperweed) and introduced perennials (Swainson pea, Russian Knapweed, whitetop, and big whitetop). Foxtail barley, alkali muhly and poverty weed are likely to come in or increase from trace amounts where there is influence from nearby irrigation. Invading species usually become extensive only where the original vegetation has been destroyed.

As the ecological condition deteriorates, the natural grass stand breaks up, and greasewood or rubber rabbitbrush become dominant. Saltgrass takes over some abandoned fields or similar areas where brush has been destroyed. It may till in between brush clumps in other areas, replacing alkali sacaton and other major grasses but will, in turn, decrease if deterioration continues. Baltic rush may increase on some spots. In many places the present cover is mostly greasewood or a mixture of greasewood and rubber rabbitbrush with a thin, patchy understory of saltgrass or almost no grass at all.

Range Site No. 263. 2/

f. SALT MEADOW

Physical Characteristics

(1) Physiographic Features: This site is on low-lying land associated with the Salt Flats range site in the San Luis Valley. It is mostly near main streams. In some places, it forms a band between the Wet Meadow and Salt Flats range sites. The ground surface may be smooth and nearly level or gently undulating due to old channels, oxbows, and swales. Slopes are mostly 0 to 1% and have no significant effect on plant growth. Elevation is 7,500 to 7,700

feet (2,286 to 2,347 m), except for a few localized spots at slightly higher elevations.

(2) Climatic Features: Average annual precipitation is 6 to 8 inches (0.15 to 0.2 m), possibly reaching 10 inches at some upper elevations. Of this, 55 to 60% falls between May 1 and September 1, mostly from hard, spotty thundershowers of short duration in July and August. May and June are normally dry. Wide seasonal and yearly variations are common. Major plants make their main growth between mid-May and late July. A few plants are slightly earlier.

Mean annual temperature is 41° to 43° F. (5 to 6.1° C). Average frost-free period is 95 to 105 days, from late May or early June to September. Summer daytime temperatures are frequently in the 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Temperatures of -20° to -30° F. (-28.9 to -34.4° C) can be expected each year and are common some winters. Lower extremes are sometimes recorded.

Winds that often reach high velocities are common, especially in spring. Relative humidity is usually low. Even so, evaporation rates average lower than those of many dry regions because of the cool climate. Snow cover is often light and is sometimes lacking through much of the winter. There is usually some snow, though, during the coldest weather.

(3) Native (potential) Vegetation: A rather uniform stand of grasses gives the site a smooth, meadow-like appearance. The plant community is dominated by various mixtures of alkali sacaton, beardless wildrye, western wheatgrass, and alkali cordgrass. Of these, alkali sacaton is usually dominant, and may form a nearly pure stand in places, but any one of the others may dominate locally. Smaller amounts of slender wheatgrass, alkali grass, wedgegrass, saltgrass, Baltic rush, sedges, and mat muhly can be expected. Forbs appear as scattered plants or in small isolated patches, and make up a small part of the total yield. Common forbs

are lanceleaf goldenweed, dandelion, hawksbeard, dogbane, herbaceous cinquefoils, arrowgrass, horsetail, iris, and wild licorice. There may be traces of a few others. Shrubs--greasewood and rubber rabbitbrush--are widely scattered if present at all.

There are no tree species natural to the site. Approximate ground cover is 60%.

Native species likely to invade the site or significantly increase from trace amounts are foxtail barley, alkali muhly, dock, and poverty weed. Other species which may invade are swainson pea, whitetop, big whitetop, Russian Knapweed, Canada thistle, blindweed, and annuals such as Kochia. As the ecological condition deteriorates the major grasses decline and the cover generally becomes more broken. (Saltgrass or mat muhly may largely replace other grasses without serious loss of cover, however.) Some native forbs may become more prominent, especially iris, but the main change is usually from the previously dominant grasses to mixtures of saltgrass, alkali grass, mat muhly, Baltic rush, and foxtail barley or nearly pure stands of saltgrass. Invading-type plants listed above may become dominant on severely depleted areas. Greasewood and rubber rabbitbrush become prominent at some locations.

Range Site No. 267. 2/

g. SAND HUMMOCKS

Physical Characteristics

(1) Physiographic Features: This site consists of low dunes and Hummocks, usually not over 15 to 20 feet (4.6 to 6.1 m) high. These dunes are in sharp contrast to the more level rangeland or barren "chico" flats with which they are interspersed. Elevations are mostly between 7,500 and 7,600 feet (2,286 and 2,316 m).

(2) Climatic Features: Average annual precipitation is 6 to 8 inches (0.15 to 0.2 m). 55 to 60% falls between May and September. Hard rains are common during July and August, while May and June are generally dry. Drought is common and severe. The mean annual temperature is

about 42 degrees (5.6° C), with a frost-free period of 75 to 90 days. Evaporation rate is low except during periods of high winds. The optimum growing season for the major native plants is May 1 to August 15.

(3) Native (potential) Vegetation: The plant community exists as a sparse, uneven cover of grasses and taller plants of greasewood, tall rabbitbrush, and fourwing saltbush. The main grasses are saltgrass, alkali sacaton, creeping wildrye, western and thickspike wheatgrasses, and blue grama. Small amounts of sandhill muhly, sand dropseed, Indian ricegrass, baltic rush, threeawn, Kochia weed, and pirckly pear cactus will also occur.

Tree species are not a part of the natural plant community. Approximate ground cover is about 25%.

Species most likely to invade this site or increase drastically from the amounts shown above are saltgrass, sandhill muhly, foxtail barley, blue grama, sand dropseed, tall rabbit-brush, greasewood, snakeweed, and annual weeds.

Range Site No. 312. 2/

h. SANDY BENCH

Physical Characteristics

(1) Physiographic Features: This site occurs on almost level to gently sloping fans and benches. Elevation ranges from 7,500 to 8,500 feet (2,286 to 2,591 m).

(2) Climatic Features: Average annual precipitation varies from 7 to 11 inches (0.18 to 0.28 m) with about 50% coming during the period May 1 to October 1. May and June are the driest months, while July and August are the most favorable. The site is subject to frequent and severe drought periods. The mean annual temperature is about 45 degrees (7.2° C), with a frost-free period of 90-100 days. Evaporation rate is low except during periods of strong winds. The optimum growing season for major native plants is May 1 to September 1.

(3) Native (potential) Vegetation: This site occurs as a grassland-forb-shrub aspect. Dominant grasses in the plant community are bluegrass, Indian ricegrass, needle-and-thread, spike dropseed, and western wheatgrass. Smaller amounts of sand dropseed, squirreltail, slimstem muhly, and sandhill muhly may also be found. Forbs and shrubby plants such as golden pea, scarlet globemallow, yarrow, buckwheat, fringed sage, prickly pear, yucca, skunkbrush, apache plume, currant, and gooseberry are scattered in small amounts throughout the plant community.

Tree species are not a part of the natural plant community. Approximate ground cover is 30%.

Species most likely to invade this site or increase drastically from the amounts shown above are sleepy grass, slimstem muhly, three-awn, sand dropseed, blue grama, snakeweed, pingue, rabbitbrush, fringed sage, and annuals such as sunflowers, lambs quarter, Kochia, Russian thistle, and mustard. As the ecological condition deteriorates, this site may occur as a solid stand of low-growing, poor vigor blue grama and weeds.

Range Site No. 273. 2/

i. VALLEY SAND

Physical Characteristics

(1) Physiographic Features: This site occupies low sand bars and ridges within the San Luis Valley and localized areas around the edges of the Valley where there is evidence of a deep water table. Topography varies from almost level on the Valley floor to moderately sloping along the fans. Elevation ranges from 7,500 to about 8,000 feet (2,286 to 2,438 m).

(2) Climatic Features: Average annual precipitation is about 6 to 8 inches (0.15 to 0.2 m), with about 60% of this coming during the period May 1 to October 1. The best moisture months are July and August, while June is generally the driest month. Mean annual temperature is

about 42 degrees (5.6° C). Drought is both frequent and severe. The optimum growing season for the major native plants is May 1 to September 1.

(3) Native (potential) Vegetation: The vegetation is made up of both sandy land grasses and deep-rooted salt tolerant brush species. The dominant grasses are Indian ricegrass, needle-and-thread, blue grama, alkali sacaton, alkali cordgrass, western wheatgrass, creeping wildrye, and some patches of saltgrass. Fourwing saltbush and small amounts of winterfat are important browse plants. Deep-rooted greasewood and tall rabbitbrush are the most prominant shrubs. Scattered amounts of prickly-pear cactus, Russian thistle, Kochia, globe mallow, baltic rush, sedges, lambs quarter, and other annuals may be present.

Tree species are not a part of the natural plant community. Approximate ground cover is 30-35%.

Species most likely to invade this site or increase drastically from the amounts shown above are saltgrass, sand dropseed, threeawn, greasewood, tall and low rabbitbrush, prickly pear cactus, and annual weeds.

Range Site No. 294. 2/

j. WET MEADOW

Physical Characteristics

(1) Physiographic Features: The site is on nearly level to gently sloping flood plains. It commonly forms a narrow band next to a flowing stream. In places there are small irregularities caused by slightly higher or lower spots, but many of these are inclusions of other sites. Slopes are generally less than 1% and are insignificant to plant growth. Elevation is between 7,500 and 8,500 feet (2,286 and 2,591 m).

(2) Climatic Features: Average annual precipitation is 6 to 10 inches (0.16 to 0.25 m). Of this, 55% to 60% falls between May 1 and September 1, mostly from hard, spotty thundershowers of

short duration in July and August. May and June are normally dry. Wide seasonal and yearly variations are common. Growth of major native plants may start in April, but the optimum growth period is from about mid-May to late July.

Mean annual temperature is 41° to 43° F. (5 to 6.1° C), with an average frost-free period of 90 to 100 days from early June to September. Summer daytime temperatures are frequently in the 80's (26.7° C), but rarely exceed 90° F. (32.2° C), and nights are cool. Winter temperatures of 20° to 30° (-28.9 to -34.4° C) below zero are common some years and can be expected every year. Lower extremes are sometimes recorded.

The site is dependent on sub-irrigation and overflow, which largely offsets the low precipitation. Evaporation rates are held down by short, relatively cool summers. However, they are higher than the Mountain Meadow range site due to warmer summer days, lower relative humidity, and seasonal high winds.

Snow cover is often light and is sometimes lacking through much of the winter. There is usually some snow, though, during the coldest weather.

(3) Native (potential) Vegetation: Grasses and grasslike plants make up most of the cover. Tufted hairgrass and Nebraska sedge are usually dominant on the wettest portions and slender and western wheatgrasses on the driest parts. Others which may be present are bluejoint reedgrass, northern reedgrass, wedgegrass, manna grass, American sloughgrass, ovalhead sedge, and Baltic rush. Alkali sacaton and mat muhly may show up along edges where the site intergrades with salt meadow. In places, alkali sacaton is prominent on small high spots (inclusions of salt meadow) sprinkled through the site. Forbs are rather minor, although there are many species. Among the most common are New Mexico checkermallow, American vetch, native clovers, Rocky Mountain iris, wild

licorice, herbaceous cinquefoils, western yarrow, golden pea, gentain, and water hemlock. Small clumps of wild rose and streambank willow and small marshy areas supporting cattails, bulrush, and horsetail are commonly associated with the site.

Tree species do not normally grow on the site. However, an occasional cottonwood may come into areas bordering streambottom woodland. Approximate ground cover is 60%. Species most likely to invade the site or increase from trace amounts are foxtail barley, rabbitfoot grass, dandelion, dock, willows, rose, and (on drier fringes) rubber rabbitbrush. As the ecological condition deteriorates, tufted hairgrass, Nebraska sedge, slender wheatgrass, and reedgrasses usually show a sharp decline. Western wheatgrass may make a slight increase initially, but it too declines if the condition continues to deteriorate. There is a corresponding increase, often in mixture with invading plants, of some or all the following plants: Baltic rush, low sedges, mat muhly, Rocky Mountain iris, cinquefoils, and water hemlock. Nebraska sedge may retain control indefinitely on the wettest areas, but becomes extremely broken and hummocky under prolonged heavy grazing.

Range Site No. 315. 2/

D. Cropland (RED)

Irrigated cropland (RED) is land on which water is applied artificially. There is no dry land cropland in the basin. There are 609,590 acres (246,701 ha) of irrigated cropland scattered throughout the basin.

Types of crops produced on these lands vary from mountain meadow hay in the cold mountain valleys with short growing seasons to a crop rotation of alfalfa hay, barley, potatoes, and vegetable crops in the lower basin climate. Management of hay and pasture are managed to fit the weather and prices.

Irrigated cropland - Oats northwest of
Monte Vista, Colorado

E. Duneland (WHITE)

The giant dunes (WHITE) rising as much as 1,000 feet (305 m) above the basin floor, consist of constantly shifting sand. This barren, but very scenic area, has severe limitation for common land uses, but is unique and valuable for the specific recreation to which it has been reserved as a national monument.

F. Urban

Urban is not a plant cover type and is not a map delineation. It could occur within any vegetative type. It includes towns, villages, settlements, builtup areas, roads, airports, railroads and similar type areas where cover type is not a use factor.

Duneland - Great Sand Dunes National Monument

G. Barren and Others

This is not a plant cover and is not a map delineation, but knowledge of the acreages involved are essential to planners and users of the areas in which it occurs. This type includes areas on which there is little or no natural vegetation including intermittent lake beds, bodies of water of less than 40 acres (16 ha), streams less than one-eighth mile (0.2 km) in width, saline flats, active sand dunes, shale, rock, rock slides, lava flows, etc.

Areas which have been temporarily denuded by overgrazing or other causes are not included.

H. Water

This is not a plant cover type, but is included in the tables to account for the total land and water acreage. It includes water surfaces having 40 acres (16 ha) or more of area, and streams one-eighth mile (0.2 km) or more in width.

APPENDIX C

EXISTING OUTDOOR RECREATION AREAS

APPENDIX C

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FIGURES

TABLES

EXISTING OUTDOOR RECREATION AREAS

The character of the natural features, rather than the location of the basin, have dominated the kind of cultural development and thereby, affect the amount and kinds of recreational use in the area. Both archeological and historical values have a significant effect on present day recreation activities. See Figures C-1 and C-2, also Tables C-1, C-2, and C-3.

There are a number of museum facilities in the basin, both public and private as listed in Table C-1.

A prominent public museum is the Fort Garland Museum administered by the State Historical Society of Colorado. Fort Garland was established by the War Department in 1858 in what was then the Territory of New Mexico. It replaced Fort Massachusetts which had been constructed six years earlier six miles north of Fort Garland. Fort Massachusetts was closer to the mountains and was vulnerable to Indian attacks; subsequently, it was moved south to Fort Garland.

The fort was donated to the State Historical Society in 1945 and is included as one in the state system of museums. The museum recorded 79,197 visitors from May 15 through October 15, 1971 which is the major tourist period for the museum. Since the museum is a historical museum, maintenance is undertaken to preserve the adobe materials and the fort in its original state. There are no needed improvements or maintenance planned to increase the facilities at the fort. The fort has no influence on the natural environment as such.

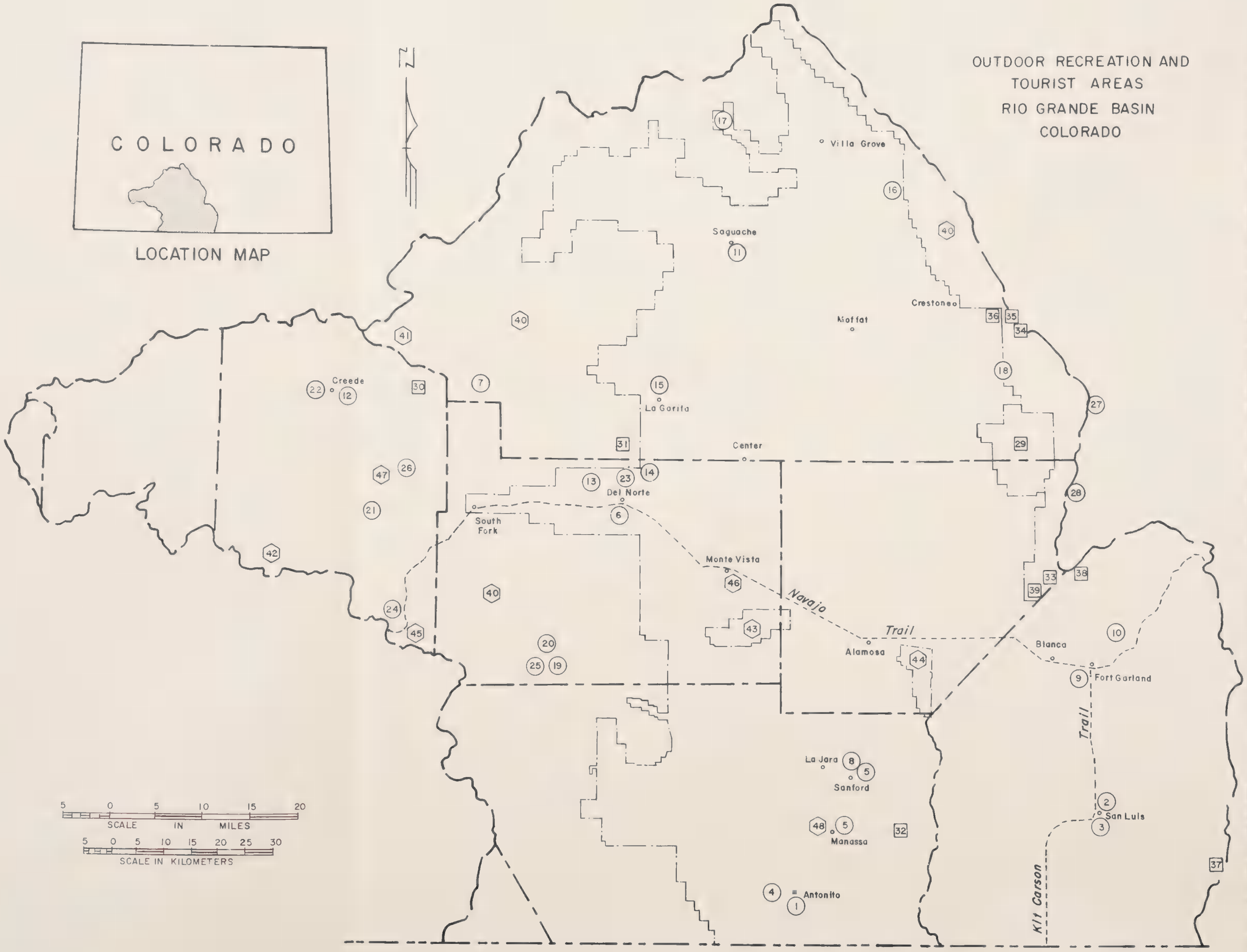
The Rio Grande County Museum was opened in June 1962. The museum contains a treasury of Old West exhibits pertaining to the history of the basin. The exhibits are housed in two rooms of the Rio Grande County Court House at the present time. According to information received from museum staff, the museum can be expanded to meet future needs and is apparently adequate to serve present functions. It does appear, however, that in the long-range development of this museum it should be housed in a separate structure from the Court House, perhaps in an old historical building in the community.

Table C-1 shows a list of other museums, including several private museums. It is important to develop and maintain these museums to preserve a record of man's history as much as possible.

Table C-2 shows a list of potential national register sites. Several of the sites are quite important, mainly, Fort Garland (mentioned earlier in this report), and the Pikes Stockade, a National Historic Landmark which is administered by the State Historical Society. Pikes Stockade is a replica of the log stockade built by Zebulon Pike in 1807.

RIO GRANDE BASIN
COLORADO
1977

FIGURE C-1



HISTORICAL VALUES

1. CUMBRES & TOLTEC SCENIC RAILROAD - ANTONITO
2. OLDEST TOWN IN COLORADO - FOUNDED IN 1851 - SAN LUIS
3. SAN LUIS PEOPLE'S DITCH - SAN LUIS
4. OLDEST CHURCH IN COLORADO - CONEJOS
5. MORMAN PIONEER DAYS CELEBRATION - SANFORD & MANASSA
6. BARLOW-SANDERSON STAGE STATION - DEL NORTE
7. FREMONT'S CAMP - SOUTH FORK
8. PIKE'S STOCKADE - SANFORD
9. FORT GARLAND - FORT GARLAND
10. FORT MASSACHUSETTS - FORT GARLAND
11. SAGUACHE MUSEUM - SAGUACHE
12. CREEDE MINING DISTRICT - CREEDE
13. INDIAN HEAD - DEL NORTE
14. WAGON TRACKS - LA GARITA
15. LA GARITA CHURCH - LA GARITA
16. ORIENT (HISTORIC MINE) - VILLA GROVE
17. BONANZA (GHOST TOWN) - VILLA GROVE
18. LIBERTY (GHOST TOWN) - CRESTONE
19. JASPER (GHOST TOWN) - DEL NORTE
20. SUMMITVILLE (GHOST TOWN) - DEL NORTE
21. SPAR CITY (GHOST TOWN) - CREEDE
22. BACHELOR (GHOST TOWN) - CREEDE
23. LOMA (GHOST TOWN) - DEL NORTE
24. WOLF CREEK PASS - SOUTH FORK
25. ELWOOD PASS - DEL NORTE
26. WAGON WHEEL GAP - WAGON WHEEL GAP
27. MEDANO PASS - MOSCA
28. MOSCA PASS - MOSCA

ARCHEOLOGICAL VALUES

29. GREAT SAND DUNES NATIONAL MONUMENT - MOSCA
30. WHEELER GEOLOGIC AREA - CREEDE
31. NATURAL ARCHES - DEL NORTE
32. KING'S TURQUOISE MINE - MANASSA
33. BLANCA PEAK (14,345') - (4372 m) - BLANCA
34. CRESTONE NEEDLE (14,197') - (4327m) - CRESTONE
35. CRESTONE PEAK (14,294') - (4357m) - CRESTONE
36. KIT CARSON PEAK (14,165') - (4317m) - CRESTONE
37. CULEBRA PEAK (14,069') - (4288m) - SAN LUIS
38. MOUNT LINDSEY (14,042') - (4280m) - BLANCA
39. LITTLE BEAR PEAK (14,037') - (4278m) - BLANCA

MAJOR RECREATION ATTRACTIONS

40. RIO GRANDE NATIONAL FOREST
41. LA GARITA WILDERNESS AREA - CREEDE
42. WEMINUCHA WILDERNESS AREA - CREEDE
43. MONTE VISTA NATIONAL WILDLIFE REFUGE - MONTE VISTA
44. ALAMOSA NATIONAL WILDLIFE REFUGE - ALAMOSA
45. WOLF CREEK SKI AREA - SOUTH FORK
46. SKI HI STAMPEDE - MONTE VISTA
47. RIO GRANDE RAFT RACES - CREEDE - DEL NORTE
48. BIRTHPLACE OF BOXER JACK DEMPSEY - MANASSA

FIGURE C-2

Local historical societies in the basin should continue to research and identify future potential historical sites in order to permit these to be placed on the National Register.

TABLE C-1
Museum Facilities
Rio Grande Basin, Colorado

Name	Location
Adams State College Museum	Alamosa
Alamosa-Narrow Gauge Railroad Museum	Alamosa
Creede Museum	Creede
Fort Garland Museum	Fort Garland
Jack Dempsey Museum	Manassa
Rio Grande County Museum	Del Norte
Saguache County Museum	Saguache

Source: Public Facilities Inventory, San Luis Valley Regional Development and Planning Commission, 1972.

TABLE C-2
Historical Sites & Potential National Register Sites
Rio Grande Basin, Colorado

Alamosa County:	D & RG Narrow Gauge shops and Depot (Alamosa) Great Sand Dunes Folsom site (south of Great Sand Dunes)
Conejos County:	Cumbres Pass and Toltec Scenic Railway (nominated) Major Lafayette Head house (Conejos) Pikes Stockade 1/
Costilla County:	Fort Garland 2/ Fort Massachusetts (six miles north of Fort Garland) San Luis Historic District
Mineral County:	Creede Historic District Ruby Lake Cabins (35 miles from Creede)
Rio Grande County:	None
Saguache County:	Cochetopa Pass

1/ National Historic Landmark - Automatically Listed.

2/ National Register of Historic Places.

Source: State Historical Society.

TABLE C-3

ACRES OF DEVELOPED RECREATIONAL RESOURCES

Rio Grande Basin, Colorado

Existing Developed Sites	Acres	(Hectares)	Inventoried Potential Sites	Acres	(Hectares)
Forest Service	720	(291) 1/	Forest Service	5,455	(2208)
Bureau of Land Management	0	(0)	Bureau of Land Management	40	(16)
State	834	(338)	State	0	(0)
Private	243	(98)	Private	200	(81)
Total Existing	1,797	(727)	Total Potential	5,695	(2305)
National Park	36,816	(14,900) 2/			

1/ Includes ski area
2/ Includes total NP area

A. Historical Values

Cumbres and Toltec Scenic Railroad

The Cumbres and Toltec Scenic Railway is owned by the states of Colorado and New Mexico. It is one of the newest and promising attractions. It runs over Cumbres Pass and Toltec Gorge from Antonito, Colorado to Chama, New Mexico, a total distance of 64 miles (103 km).

Narrow gauge steam train tour through the high mountains of Colorado and New Mexico.

San Luis

Spanish American settlers founded the town of San Luis in 1851 - the oldest town in Colorado. These settlers located at San Luis de la Culebra, now known as San Luis. The name was chosen because most of the settlers were devotees of San Luis Gonzaga, and the settlement was on Culebra (water snake) river. Hence San Luis de la Culebra. San Luis has something

that is not found anywhere else in this area. The San Luis Commons or "The San Luis Vega." It is a grassland area of 633.32 acres (256.3 ha) which is set aside forever as a pasture for use by the people of San Luis, San Pablo and San Pedro. Its use is limited to horses and cattle. This land can not be taxed, sold or rented. Each head of a family is entitled to graze four head.

San Luis Peoples Ditch - Earliest priority in Colorado.

<u>San Luis Peoples Ditch</u> - San Luis, Colorado

In 1890 the District Court of Costilla County awarded San Luis Peoples Ditch Priority No. 1 in Water District 24 of Water Division 3, dated April 10, 1852, with an allotment of 23 cubic feet per second (0.65 m^3/s) for irrigating 900 acres (364 ha). This was the earliest priority in Colorado under the system of water appropriation, adjudication, and administration.

Fort Garland, a museum maintained by the State Historical Society of Colorado.

Fort Garland

This restored Fort contains displays depicting life of the local soldiers, settlers, and indians which settled in the area. It was built in 1858 and abandoned in 1883. Colonel Kit Carson commanded the Fort for a period of time.

Creede Mining District

Creede Mining District

Creede has active mines and is a famous town for depicting early mining in the Rio Grande Basin. Creede also provides a summer season of repertory theater which gives tourists an example of entertainment provided during the early history in mining towns.

Oldest Church Edifice in Colorado

The oldest church edifice in Colorado, Our Lady of Guadalupe Catholic Church, is situated in the Town of Conejos. It was started in 1854 and finished in 1859 and is still in use.

Homestake Mine at Creede, Colorado

Pike's Stockade

In February 1807 Lieutenant Zebulon M. Pike built a military post at the junction of the Conejos River and Rio Grande. Pike's Stockade is a replica of the moated log stockade which he built.

Bonanza

Mining is inactive in this historic mining town in the northern part of the basin.

Summitville

A historic mining town at the head of the Alamosa River.

Mosca Pass

This pass was used by early explorers crossing the Sangre de Cristo Range.

Elwood Pass

Elwood Pass was an early route over the San Juan Mountains near Summitville.

Wolf Creek Pass

A scenic pass over the Continental Divide.

Wagon Tracks - LaGarita

Tracks cut in sandstone rock by iron rim wagon wheels. These wagons hauled timber from the Cochetopa Hills and LaGarita Mountains to the basin for construction.

Wagon tracks west of La Garita, Colorado on La Garita and Carnero Creeks.

B. Archeological Values

Great Sand Dunes National Monument

Great Sand Dunes National Monument

Great Sand Dunes National Monument is administered by the National Park Service. The 36,817 acre (14,900 ha) monument is located against the Sangre de Cristo's mountain range. The dunes are the highest piled inland sand dunes in the United States. They are noted for the peculiar and colorful shadows arising from the shifting sands. The monument has exhibitions in its visitor center and provides campgrounds, picnic areas, hiking trails, and naturalist activities.

Wheeler Geologic Area

Fantastic stone formations in a remote setting.

Mountain Peaks Over 14,000 Feet (5,666 m)

There are seven mountain peaks in the Sangre de Cristo Range which exceed the 14,000 feet (5,666 m) elevation. They are as follows: Blanca Peak, Crestone Peak, Crestone Needle, Kit Carson Peak, Culebra Peak, Mount Linsey, and Little Bear Peak.

C. Major Recreation Attractions

Rio Grande National Forest

The Rio Grande National Forest, 1.8 million acres (0.73 million ha) of forest and range land, administered by the U. S. Forest Service contains more than 1,600 miles (2,574 km) of forest roads and 1,280 miles (2,060 km) of foot or horseback trails. There are 463,920 (187,748 ha) acres of inventoried roadless areas.

Variety is the word describing the outdoor recreation opportunities. From the rugged and jagged peaks of the Sangre de Cristo's to the forested table lands and glacial canyons of the San Juan's, the outdoor enthusiast can choose an activity suited to the day or the season.

High lakes and tumbling streams beckon the fisherman, while big game and other wildlife lure the hunter or nature photographer. Hiking, riding, backpacking, camping, boating, skiing, picnicking, snowmobiling and nature study.

La Garita and Weminuche Wilderness Areas

Portions of these wilderness areas are located 149,609 acres (60,547 ha) in the Rio Grande Forest. These areas are closed to motor vehicles at all times. Hiking, backpacking and camping amid spectacular scenery await the visitor in these areas.

Monte Vista and Alamosa National Wildlife Refuges

The Monte Vista National Wildlife Refuge, 12,836 acres (5,795 ha) and Alamosa National Wildlife Refuge, 10,360 acres (4,193 ha) are administered by the U. S. Fish and Wildlife Service. The primary purposes of these refuges are to create suitable nesting habitat for migratory birds and upland game, and to provide food and protection for wintering waterfowl. Hunting, birdwatching, limited fishing, sightseeing, picnicing, nature study, and photography are permitted on the refuges.

Wolf Creek Ski Area

Skiing - Wolf Creek Pass

Wolf Creek Ski Area is usually the first ski area in Colorado to open in the fall and the last to close in the spring. It has the second heaviest snowfall of any area in the United States, thus offering some advantages for intensification.

Ski Hi Stampede

Since 1919 the Ski Hi Stampede has been celebrated in the town of Monte Vista. It includes a parade, carnival, professional rodeo, dances, and pari-mutuel racing.

Rio Grande Raft Races

During the second week of June each summer raft races are held on the Rio Grande. This race goes from Creede to South Fork.

Birth Place of Boxer Jack Dempsey

Manassa is the birth place of ex-heavy-weight boxer Jack Dempsey, who was heavy-weight champion from 1919 to 1926. The Manassa City Park has a monument to honor him.

APPENDIX D

WATER QUALITY

APPENDIX D

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WATER QUALITY

1. Surface Water

With the exception of Kerber, Willow, and Alamosa Creeks, which are affected by mine drainage, the chemical quality of the stream water is generally excellent as is typical of high mountain streams. Specific-conductance measurements were made periodically on 32 representative streams, and major chemical constituents were determined on water samples collected monthly from 14 of those 32 streams during the 1967-68 water year. These data indicate the dissolved-solids concentration ranged from 25 to 450 mg/l (milligrams per liter), and the water is a calcium bicarbonate type in streams unaffected by mine drainage. Water in the streams affected by mine drainage is calcium sulfate in composition. Specific-conductance values exceeded 500 microhoms in only 4 of the 32 sampled streams. Table D-1 lists the specific-conductance values for each stream.

As water from the Rio Grande flows through the basin, its chemical quality is influenced by many factors, such as: irrigation diversions and return flow, tributary inflow, and ground-water inflow. The water in the Rio Grande at Del Norte, where it enters the basin, ranged from a calcium bicarbonate to a calcium magnesium bicarbonate type, and the specific conductance ranged from 46 to 136 umhos/cm (micromhos per centimeter) during the 1-year sampling period. Above Del Norte, natural effects principally control the water quality, whereas below Del Norte the use of the water for agriculture, industry, and public supply, in addition to natural effects, act collectively to increase dissolved solids in a downstream direction.

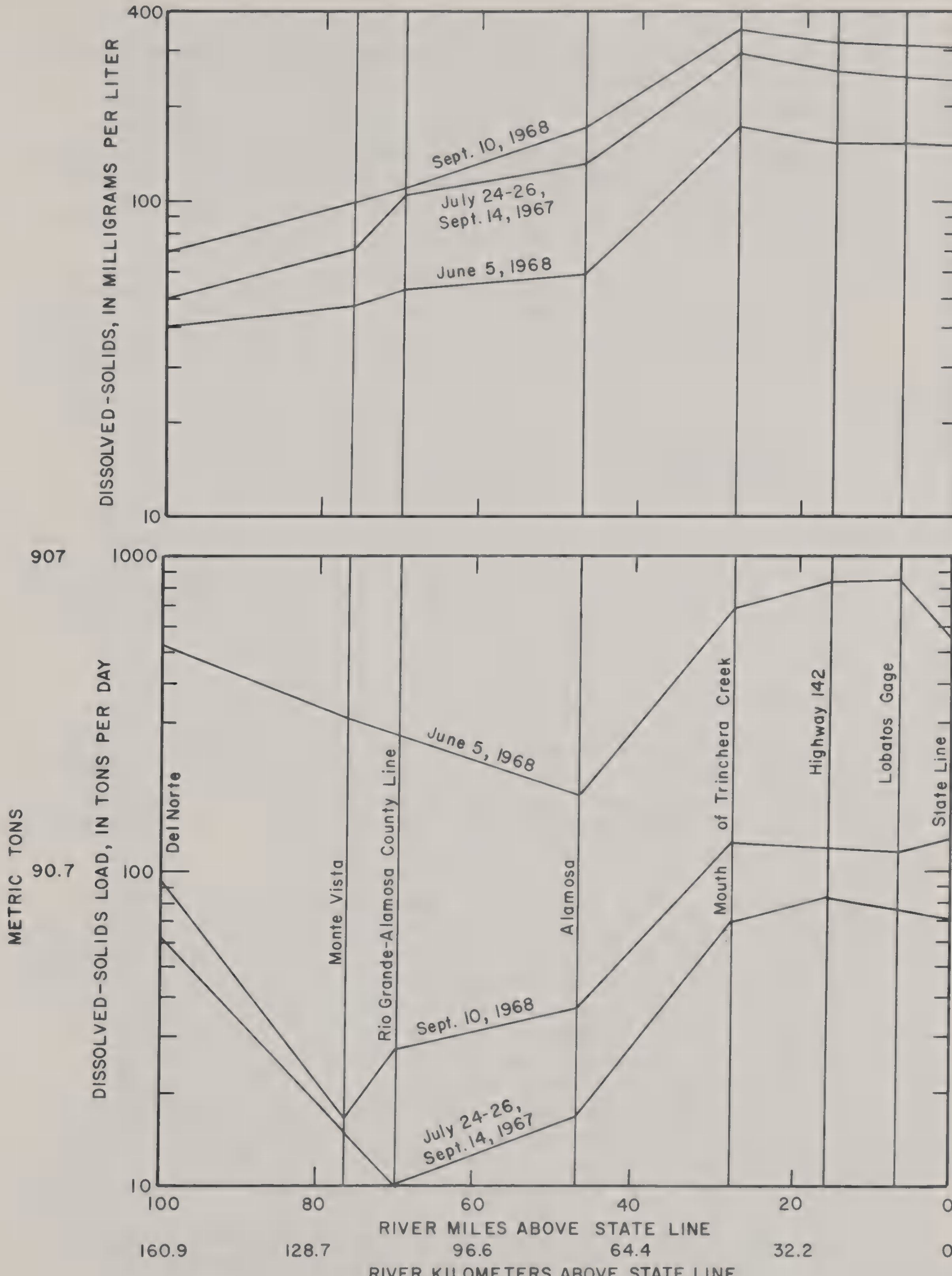
Water from various localities was sampled to determine the relationship between discharge and dissolved-solids concentration. In addition, historic data were employed to determine long-term trends. Figure D-1 shows the dissolved-solids load at various locations along the Rio Grande at three different times. Generally, the specific conductance increased downstream, with the greatest increase occurring in the reach from Alamosa to the Mouth of Trinchera Creek. The large dissolved-solids loads at Del Norte are due to high discharges of relatively dilute water. As diversions deplete the flow of the river, the load decreases proportionally as shown. Near the Rio Grande-Alamosa County line, irrigation return flow and ground-water inflow from approximately 243,000 acres (98,342 ha) cause an increase in the dissolved-solids load. The largest increase, regardless of season, occurs in the reach between Alamosa and the mouth of Trinchera Creek. From the mouth of Trinchera Creek to the state line, both the dissolved-solids load and the concentration remain relatively constant.

Table D-1

Specific Conductance of Surface Water
Rio Grande Basin, Colorado

Stream	Range of specific conductance (micromhos per centimeter at 25°C)	Range of flow during measurements (cubic feet per second) m³/s	Period of measurements	Number of measurements during period	Stream	Range of specific conductance (micromhos per centimeter at 25°C)	Range of flow during measurements (cubic feet per second) m³/s	Period of measurements	Number of measurements during period
Rito Hondo Creek	75-175	0.1-6.8 (0.003-0.191)	4-10-67 to 9-15-68	6	Raspberry Creek[1]	50-90	0.2-2.5 (0.006-0.070)	1-30-67 6-16-69	32
Conejos River[1]	40-97	44-1,360 (1,238-38,266)	10-11-67 to 9-30-68	11	Hayden Pass Creek	230-250	.2-1.5 (0.006-0.042)	6-3-68 to 7-1-68	3
La Jara Creek	130-162	1.1-6.7 (0.031-0.189)	9-3-67 to 8-8-69	2	Steel Creek	165-220	1.0-7.3 (0.028-0.205)	4-17-69 to 6-16-69	4
Hot Creek	150-240	6.2-15 (0.174-0.422)	12-7-66 to 4-24-69	14	Garner Creek	460-600	.9-2.7 (0.025-0.076)	1-11-67 to 12-12-68	14
Alamosa River[1]	100-292	15-267 (0.422-7,513)	10-13-67 to 9-20-68	11	Cotton Creek[1]	180-360	4.7-40 (0.132-1.125)	1-30-67 to 6-16-69	41
Cato Creek	140-290	.2-20 (0.006-0.563)	5-10-67 to 12-9-68	12	Wild Cherry Creek	100-205	.4-16 (0.011-0.450)	1-30-67 to 12-12-68	13
Rock Creek[1]	57-83	2.0-66 (0.056-1,857)	10-13-67 to 9-1-68	11	Rito Alto Creek	52-125	3.3-57 (0.093-1.604)	6-13-67 to 5-1-69	15
Raton Creek	80-185	.4-18 (0.011-0.506)	4-7-67 to 12-10-68	12	San Isabel Creek	73-110	2.1-15 (0.059-0.422)	3-29-67 to 10-18-68	1
San Francisco Creek	30-110	1.2-23 (0.034-0.647)	4-7-67 to 5-5-69	21	North Crestone Creek[1]	90-150	1.5-39 (0.042-1.097)	12-12-68 to 7-2-68	
Rio Grande[1]	46-136	130-4,370 (3,658-122,959)	10-18-67 to 9-1-68	12	Cottonwood Creek[1]	40-100	.8-24 (0.025-0.675)	3-21-67 to 5-20-69	29
Rio Grande	60-162	58-2,290 (1.632-64,433)	1-27-67 to 9-10-68	6	Madano Creek	68-140	2.0-54 (0.056-1.519)	5-6-68 to 6-11-69	14
Rio Grande	92-296	26-1,290 (0.732-36.297)	1-27-67 to 12-12-68	12	Mosca Creek[1]	120-280	.1-4.2 (0.003-0.118)	1-11-67 to 5-20-69	39
Rio Grande[1]	177-740	44-1,720 (1,238-48,395)	10-26-67 to 9-29-68	12	Middle Zapata Creek	70-104	.5-15 (0.014-0.422)	2-13-67 to 10-13-68	16
Carnero Creek[1]	136-265	2.0-165 (0.056-4.643)	10-18-67 to 9-2-68	12	Sangre de Cristo Creek	230-429	1.6-92 (0.045-2.589)	10-16-67 to 9-16-68	12
Saguache Creek[1]	102-177	22-340 (0.619-9.567)	10-18-67 to 9-2-68	12	Culebra Creek[1]	115-161	9.5-127 (0.267-3.573)	10-18-67 to 9-16-68	11
Little Kerber Creek	395-325	.1-1.5 (0.003-0.042)	3-14-67 to 11-9-68	13	Vallejos Creek	67-100	3.4-22 (0.096-0.619)	3-7-67 to 10-4-67	[illegible]
Kerber Creek[1]	107-667	2.5-48 (0.070-1.351)	10-18-67 to 9-6-68	12	San Francisco Creek	60-120	3.2-26 (0.090-0.731)	2-14-67 to 11-14-68	16
San Luis Creek	175-405	.2-1.5 (0.006-0.042)	12-13-66 to 11-9-68	15					

[1] Chemical analyses published in U.S. Geological Survey, 1968, Water Resources Data for Colorado, Part 2, Water Quality Records.



Dissolved-solids load and dissolved-solids concentration
RIO GRANDE BASIN
COLORADO

FIGURE D-1

Because a greater amount of salt is being supplied to the irrigated land than the Rio Grande is removing, an unfavorable dissolved-solids or salt balance exists above Alamosa. This undesirable characteristic is detrimental to the irrigated land, and proper management of the areas affected is necessary in order to maintain the proper plant growth and crop yield. Below Alamosa the salt balance is more favorable, as the river removes more salt from the surrounding area than it contributes.

The quality of water in the Rio Grande near Lobatos is the result of all factors affecting the river as it flows through the basin. The observed minimum and maximum dissolved-solids concentration and percent sodium, October 1946 to October 1965, are shown in Table D-2.

Figure D-2 shows the 1946-65 average monthly discharge and the average monthly discharge-weighted dissolved-solids concentration and percent sodium for water in the Rio Grande near Lobatos. Generally, the discharge and the dissolved-solids concentration is high. The somewhat anomalous peaks in dissolved solids and percent sodium in March are probably the result of overland runoff from snowmelt within the basin. This runoff dissolves the "alkali" (mainly sodium sulfate) from the soil as the water drains into the Rio Grande. Overland runoff probably accounts for similar peaks in August.

2. Ground Water

The chemical quality of water in the unconfined aquifer is the result of many complex and interrelated factors. These factors include: chemical quality of the recharge water, mineralogy of the soils and sediments through which the water moves, and the concentrating effect of evapotranspiration.

The chemical quality of water in the unconfined aquifer is excellent around the rim of the basin. The specific conductance of the water is usually less than 250 umhos/cm, and the water is a calcium bicarbonate type. As the ground water flows toward the center of the basin, a deterioration in water quality occurs. Continued dissolution of soluble minerals from the soils and sediments as the water is recirculated through the irrigation cycle causes the dissolved-solids concentration to increase. In areas where the depth to water is less than 12 feet (3.7 m), evapotranspiration removes virtually distilled water from the unconfined aquifer causing further increase of dissolved solids in the water remaining in the aquifer.

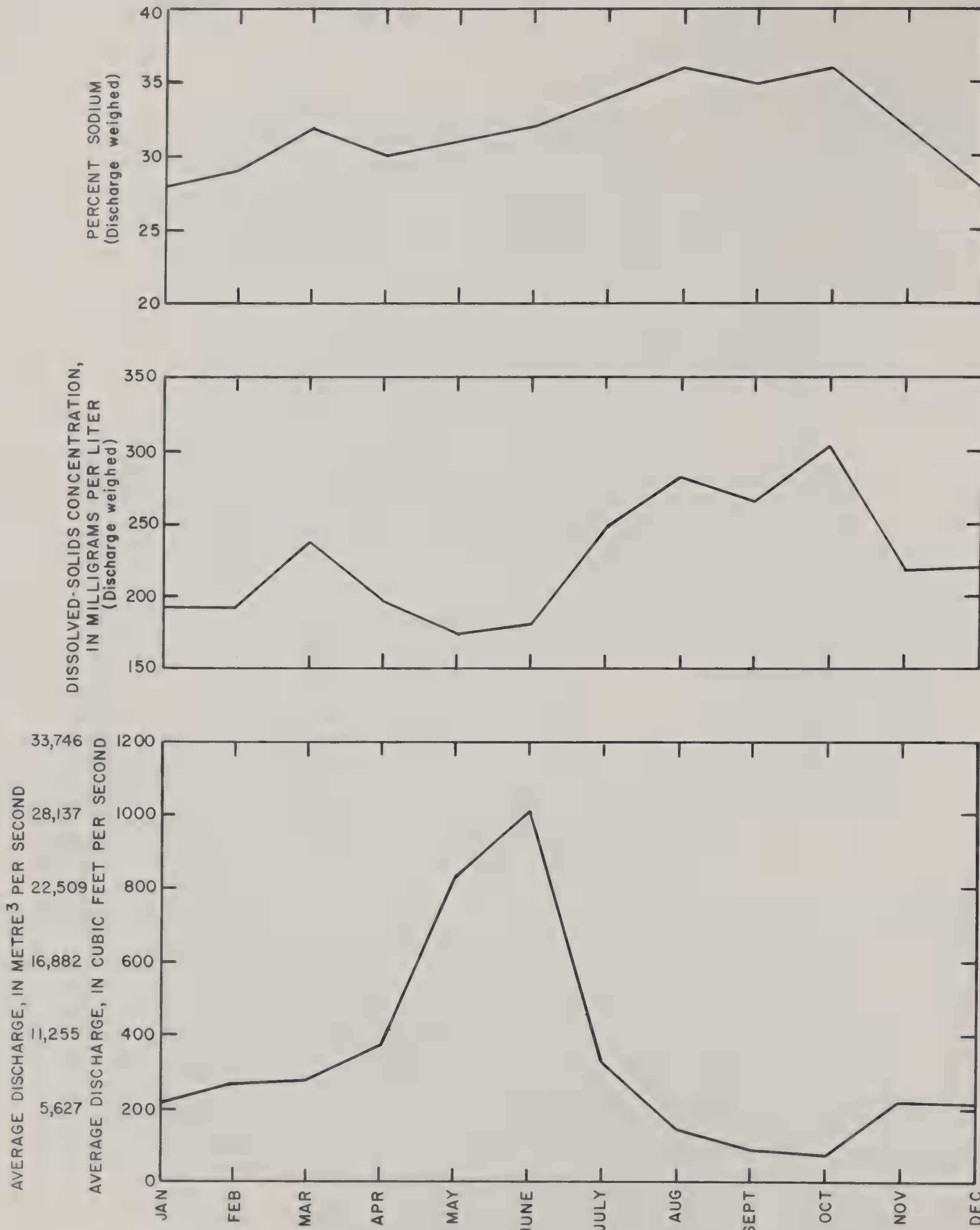
Nitrate was detected in excessive concentrations in the unconfined ground water of the Rio Grande fan. The high concentration of

TABLE D-2

Observed minimum and maximum dissolved-solids concentration and percent sodium, Rio Grande near Lobatos, October 1946 to October 1965

Rio Grande Basin, Colorado

	Mean discharge (cubic feet per second)	m^3/s	Dissolved-solids concentration (milligrams per liter)	Percent sodium
December 1, 3-10, 1946---	378	10.6	178	16
May 11-14, 1957----------	896	25.2	404	72
September 21, 1959-------	9.4	0.3	805	68
November 12-16, 1964----	467	13.1	99	26



AVERAGE MONTHLY PERCENT SODIUM, DISSOLVED-SOLIDS CONCENTRATION, AND DISCHARGE FOR THE RIO GRANDE NEAR LOBATOS, OCT. 1946 TO OCT. 1965.

RIO GRANDE BASIN
COLORADO

FIGURE D-2

nitrate is probably the result of heavy applications of chemical fertilizer during the last decade. J. W. Powell (1958, Ground-Water Resources of the San Luis Valley, Colorado, U. S. Geological Survey Water Supply Paper 1379) makes no mention of high nitrate concentrations in this area.

Nitrate concentration is variable in waters of the unconfined aquifer. Concentration is primarily a function of depth--a well 45 feet (13.7 m) deep will have a higher nitrate concentration than a well 90 feet (27.4 m) deep. Water from any well less than 100 feet (30.5 m) deep within the area of nitrate concentration of more than 10 mg/l should be tested for nitrate content before it is used for drinking.

The quality of water in the confined aquifer near the edge of the basin is excellent; the specific conductance (an index of dissolved-solids concentration) is generally less than 200 umhos/cm. The chemical quality of the water in the aquifer near the basin perimeter reflects the quality of the recharge water. As the confined water moves down-gradient, the presence of clay beds, lava flows, and minerals in the basin fill exert their influence, both chemically and physically to change the general composition of the water. Compositional changes take place at a faster rate than concentration. Ion exchange with clay in the aquifer accounts for a loss in calcium and an increase in sodium. Silicate hydrolysis contributes to the alkaline pH, and as the water moves toward the center of the basin, it becomes a sodium bicarbonate type.

Medium- and high-sodium (alkali) hazard water exists in a much larger area in the confined system than in the unconfined. Inasmuch as the high-alkali-hazard water underlies arable land in some areas, it is utilized for irrigation. However, the soil in these areas is clayey, and the danger of reducing the soil permeability exists.

In the central part of the closed basin between the depths of 100 and 1,000 feet, (30.5 and 305 m) the water of the confined aquifer has a brownish color and contains gas. Part of the gas is flammable and contains hydrogen sulfide. Although the color agent in the water is itself generally considered harmless, it is commonly associated with high-flouride concentrations, high- to very high salinity hazard, medium- to high-alkali hazard, and the above mentioned gases.

Fossil peat beds in buried lake deposits are believed to account for the organic derivatives that impart the brown color to the sodium bicarbonate water.

Flouride concentrations ranges from 0.1 to 13 mg/l in water from the confined aquifer.

The recommended limit for fluoride in drinking water (U. S. Public Health Service, 1962) is a function of annual average maximum daily air temperature. In the basin the recommended limit is about 1.3 mg/l. It is apparent that this limit is exceeded in a large area. The flouride concentration increases with depth and distance from the basin periphery. Water from depths of about 800 feet (244 m) or more generally contains higher amounts of flouride than does water from shallower depths.

With few exceptions, the temperature of water in the confined acquifer is directly related to depth. The average temperature gradient is about 1.2° C (2.2° F) per 100 feet (30.5 m) of depth. Comparison of this gradient with work by Van Orstrand (1935) indicates this temperature gradient is not extreme. Working with similar depths, Van Orstrand concluded that the range in temperature gradients for nonvolcanic areas is 0.7° to 2.7°C per 100 feet (30.5 m).

APPENDIX E

WATER SUPPLY FORECASTING PROGRAM

APPENDIX E

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WATER SUPPLY FORECASTING

Snow surveys have been made in the Rio Grande Basin since 1935. This cooperative program provides a means of water supply forecasting. Water from melting snow provides as much as 80% of the total water for the basin. Underground storage fluctuates with the snowpack.

Having advanced knowledge of water supplies enables the ranchers, farmers, and other water users to better utilize their water.

There are 20 snow courses in the basin and a number in immediately adjacent drainages (Table E-1 and Figure E-1). Snow courses are protected areas where snow is measured periodically in exactly the same spot. Many of these courses have been manually read since 1935.

A new automatic system called SNOTEL will be activated this year (1977). These sites (Figure E-2) will measure snow water equivalent, utilizing stainless steel pillows as the sensor, precipitation, and temperature. Readings will be taken automatically once a day in the early morning. Other readings can be taken on demand.

SNOTEL is using a radio transmitting and receiving method called meteor burst. A radio signal originating at a master station keys remote sites by reflecting the signal from the ionized track of a meteorite entering the earth's atmosphere. The remote site responds to the signal and reports hydrometeorological data at the site. The sites answer in order of priority over the entire western states. Master stations will be located at Boise, Idaho, and Ogden, Utah. One will be used as back-up in case of failure of the other.

The master stations will be controlled by the technical center in Portland. Data will be screened for accuracy and transmitted to the headquarters of the Soil Conservation Service (SCS) in each state.

Seven SNOTEL sites will be located in the Rio Grande or immediately adjacent drainages.

Streams originating on the western side of the basin are characterized by high winter snows and relatively low summer precipitation.

Forecasts are extremely important and accurate under these conditions.

Streams in the northern end of the basin originate at relatively low elevations and provide little runoff. The Sangre de Cristo Mountains on the eastern side of the valley are high, but have limited snow storage area. They provide only limited water supplies.

Water supply bulletins are issued each month February through April. Special reports are issued January 1, May 15 and June 1.

TABLE E-1

LIST AND LOCATION OF SNOW COURSES AND SOIL MOISTURE STATIONS
Rio Grande Basin, Colorado

Name	No.	State	Sec.	Twp.	Rge.	Elevation (ft.)	(m)
Brown Cabin	5M4	CO	1	29S	72W	9,725	2,964
Cochetopa Pass	6L6	CO	12	45S	3E	10,000	3,048
Cottonwood	5M2	CO	22	29S	72W	10,300	3,139
Culebra	5M3S	CO	Lat. 37° 10'	Long	105° 12'N	10,000	3,048
Culebra #2	5M10	CO	Lat. 37° 12'	Long	105° 12'	10,500	3,200
Cumbres Pass	6M7	CO	17	32S	5E	10,000	3,048
Cumbres Trestle	6M22S	CO	18	32N	5E	10,000	3,048
Grayback	6M21	CO	10	37N	4E	11,000	3,353
Hiway	6M19	CO	5	37N	2E	10,700	3,262
Lake Humphrey	6M15S	CO	33	40N	1E	9,300	2,835
LaManga	6M11	CO	11	33N	5E	10,000	3,048
LaVeta North	5M11	CO	14	28S	70W	9,500	2,896
LaVeta Pass	5M11	CO	22	28S	70W	9,300	2,835
Love Lake	6M20	CO	6	39N	1W	10,000	3,048
Pass Creek	6M18	CO	16	38N	2E	9,200	2,804
Platoro	6M9	CO	22	36N	4E	9,950	3,033
Pool Table Mt.	6M14P	CO	19	41N	2E	10,000	3,048
Porcupine	7M20	CO	2	41N	3W	10,400	3,170
River Springs	6M05	CO	25	33N	6E	9,300	2,835
Santa Maria	7M17S	CO	8	41N	2W	9,700	2,967
Silver Lakes	6M04	CO	15	36N	5E	9,600	2,926
Trinchera	5M8	CO	35	30S	70W	11,000	3,353
Upper Rio Grande	7M16	CO	13	40N	4W	9,350	2,850
Wolf Creek Pass	6M01	CO	4	37N	2E	10,200	3,109

S - SNOTEL site installation or proposed.
P - Preceipitation station on the snow course.

SNOTEL SITES
RIO GRANDE BASIN
COLORADO
1977

FIGURE E-1

USDA-SCS-PORTLAND, OR. 1978

SNOTEL SITE
RIO GRANDE BASIN, COLORADO

FIGURE E- 2

Forecasts are made at the following gaging stations:

Alamosa Creek above Terrace Reservoir
Conejos River near Mogote
Culebra Creek at San Luis
Rio Grande at 30 Mile Bridge (48.3 km Bridge)
Rio Grande near Del Norte
South Fork of Rio Grande at South Fork

Forecast accuracy on these streams is relatively good. Average errors range from 9% to a high of 16% except for the Culebra. The Culebra presents some problems in forecasting due to its relatively small flows and limited snow catchment area.

It is hoped that forecast accuracy will be greatly improved on the Culebra and somewhat improved on all the other basins with the additional data from SNOTEL.

A pilot project was initiated in 1975 to evaluate total snow cover in the Rio Grande Basin utilizing LANDSAT photo imagery. LANDSAT are the letters used to identify NASA's satellite used to photograph all the land masses of the world. There are two LANDSAT's and they photograph every section of the world every 9 days. A 5-year study was developed with NASA to ascertain if snow cover could be used as another variable in the forecast formula. Several other possibilities exist for use of the data from the satellite pictures: monitoring crops, sprinkler systems, range lands, and uncultivated lands.

Since a large amount of data will become available once the SNOTEL sites are activated, modeling becomes a real possibility.

This would utilize the total water balance equation for the basin and provide input and output data on a daily basis.

Forecasting of any stream in the basin could be updated daily if desired. This would also provide a good deal of insight into the potential flooding or drought on any given year. Modeling of the Conejos Basin is utilizing the computer terminal at the SCS state office and the facilities at the Fort Collins Computer Center.

This model became operational in 1977.

A number of agencies cooperate in the snow survey program in the Rio Grande Drainage including the U. S. Forest Service, Colorado State Engineer, U. S. Geological Survey, Trinchera Irrigation Company, Santa Maria Reservoir Company, San Luis Irrigation Company and National Weather Service.

At the present time snow survey installations are adequate. If additional data for forecasting are needed, appropriate changes to the system will be made.

APPENDIX F

EMPLOYMENT

APPENDIX F

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EMPLOYMENT

Employment in the basin is distributed as follows: wholesale and retail trade - 21.3 percent; agriculture - 19.0 percent; government - 18.6 percent; services - 17.8 percent; and unemployed - 23.3 percent. Mining is relatively insignificant as an employer and in value of production, but it is nontheless, extremely important in a few specific locations, particularly in Mineral County.

According to U. S. Census figures, 12,867 persons or approximately 34 percent of the Rio Grande Basin population 16 years of age and over were in the civilian labor force in 1970. The percentage of the work force was five percent below the state of Colorado's 30 percent. Some 11,655 persons, or slightly less than half of the population 16 years or over, are not in the labor force. Of this total, only three percent are considered able to work, while the remainder are homemakers, persons over age 65, students, disabled or handicapped, and a small percentage are inmates of institutions.

A number of constraints have affected industrial development and employment growth in the area. The distance of the basin from markets and imposition of freight tariffs on all goods entering and leaving the area often deter from its consideration as a favorable location for doing business or undertaking production operations. Other factors limiting growth and job opportunities include replacement of workers by automated equipment in the agricultural industry; a high proportion of unskilled workers in the labor force; limited water resources and other public facilities needed for industrial purposes; and the basin's delicate natural environment which is highly sensitive to industrial operations requiring extensive disposal of waste products.

The basin has a higher rate of unemployment than the state of Colorado. The unemployment rates are much higher for the valley's 46 percent Spanish-surnamed population. Some 9.0 percent of the Spanish-surnamed labor force experienced unemployment according to the 1970 Census records. Spanish-surnamed males experienced a 10.7 percent rate of unemployment compared with the six-county male population as a whole which had 4.9 percent unemployment. (See Tables F-1 through F-6).

TABLE F-1

INDUSTRY-OCCUPATION MATRIX OF TOTAL EMPLOYED YEAR-AROUND (1974)

Rio Grande Basin, Colorado

Sectors	Professional and Technical	Managers and Administrators	Sales	Clerical	Craftsmen, Foreman & Mechanics	Equipment Operators	Service Workers	Laborers Non-Farm	Farm Labor and Farm Foreman	Total
1 Livestock	0	515	0	0	0	0	0	0	515	1030
2 Food Crops	0	522	2	1	10	2	0	1	365	903
3 Feed Crops	0	107	1	0	4	1	0	1	71	185
4 Truck Crops & Other Agriculture	0	30	2	2	4	1	0	0	14	53
5 Agricultural Services	27	26	10	21	14	5	0	10	0	113
6 Mining	12	4	1	4	8	35	2	184	0	250
7 Construction	17	45	2	9	120	24	5	33	0	255
8 Food & Kindred Products	3	27	10	29	53	107	15	27	0	271
9 Clothing, Leather, & Jewelry	0	7	2	6	88	95	2	10	0	210
10 Logging	0	8	0	0	25	16	0	2	0	51
11 Sawmills	0	11	1	5	25	63	5	39	0	149
12 Printing & Publishing	22	9	4	5	12	0	0	1	0	53
13 Agricultural Chemicals	0	3	0	3	3	9	0	2	0	20
14 Other Manufacturing	11	9	1	6	23	59	3	148	0	260
15 Transportation & Warehousing	1	22	0	18	35	158	1	13	0	248
16 Communication & Utilities	43	33	6	114	128	31	10	28	0	393
17 Wholesale Trade	0	15	22	14	10	23	2	9	0	95
18 Automobile Dealers & Gas Stations	0	104	24	9	55	200	25	18	0	435
19 Eating & Drinking Places	2	71	0	11	4	1	384	2	0	475
20 Other Retail Trade	28	172	335	190	88	89	48	72	0	1022
21 Finance, Insurance, & Real Estate	1	55	149	168	0	0	18	0	0	391
22 Personal & Repair Service	18	46	5	38	63	46	90	11	0	317
23 Business & Professional Services	377	39	9	172	22	22	290	7	0	938
TOTAL	562	1880	586	825	794	987	900	618	965	8117

TABLE F-2

INDUSTRY-OCCUPATION MATRIX OF WOMEN EMPLOYED YEAR-AROUND (1974)

Rio Grande Basin, Colorado

Sectors	Professional and Technical	Managers and Administrators	Sales	Clerical	Craftsmen, Foreman & Mechanics	Equipment Operators	Service Workers	Laborers Non-Farm	Farm Labor and Farm Foreman	Total
1 Livestock	0	0	0	0	0	0	0	0	0	0
2 Food Crops	0	7	0	2	0	0	0	0	0	9
3 Feed Crops	0	2	0	0	0	0	0	0	0	2
4 Truck Crops & Other Agriculture	0	1	0	0	0	0	0	0	0	1
5 Agricultural Services	2	0	0	26	0	0	0	0	0	28
6 Mining	0	0	0	4	0	0	0	0	0	4
7 Construction	0	0	0	6	0	0	0	0	0	6
8 Food & Kindred Products	0	0	0	[illegible]	0	81	0	0	0	89
9 Clothing, Leather, & Jewelry	0	0	0	6	65	87	0	0	0	158
10 Logging	0	0	0	0	0	0	0	0	0	0
11 Sawmills	0	0	0	4	0	1	0	0	0	5
12 Printing & Publishing	3	6	0	5	4	0	0	0	0	18
13 Agricultural Chemicals	0	0	0	3	0	0	0	0	0	3
14 Other Manufacturing	0	0	0	6	2	9	0	0	0	17
15 Transportation & Warehousing	0	0	0	7	0	8	0	0	0	15
16 Communication & Utilities	5	3	1	85	2	3	1	0	0	100
17 Wholesale Trade	0	1	2	1	1	0	1	0	0	6
18 Automobile Dealers & Gas Stations	0	0	0	9	0	0	0	0	0	9
19 Eating & Drinking Places	0	15	0	8	1	0	226	0	0	250
20 Other Retail Trade	8	42	220	150	15	20	30	13	0	498
21 Finance, Insurance, & Real Estate	0	1	17	104	0	0	1	0	0	123
22 Personal & Repair Service	5	14	3	31	4	24	141	1	0	223
23 Business & Professional Services	193	13	4	156	2	12	218	2	0	600
TOTAL	216	105	247	621	96	245	618	16	0	2164

TABLE F-3

INDUSTRY-OCCUPATION MATRIX OF MINORITIES* EMPLOYED YEAR-AROUND (1974)

Rio Grande Basin, Colorado

Sectors	Professional and Technical	Managers and Administrators	Sales	Clerical	Craftsmen, Foreman & Mechanics	Equipment Operators	Service Workers	Laborers Non-Farm	Farm Labor and Farm Foreman	Total
1 Livestock	0	50	0	0	0	0	0	0	100	150
2 Food Crops	0	163	1	0	1	1	0	1	365	532
3 Feed Crops	0	34	0	0	0	0	0	0	71	105
4 Truck Crops & Other Agriculture	0	10	1	0	0	0	0	0	14	25
5 Agricultural Services	2	0	1	0	0	0	0	0	0	3
6 Mining	0	0	0	0	1	5	0	8	0	14
7 Construction	1	2	0	0	12	3	1	8	0	27
8 Food & Kindred Products	0	0	0	1	0	86	0	11	0	98
9 Clothing, Leather, & Jewelry	0	1	0	3	71	82	2	5	0	164
10 Logging	0	0	0	0	8	9	0	1	0	18
11 Sawmills	0	0	0	2	10	45	5	34	0	96
12 Printing & Publishing	5	1	0	1	4	0	0	0	0	11
13 Agricultural Chemicals	0	0	0	0	0	5	0	0	0	5
14 Other Manufacturing	2	0	0	4	10	43	3	62	0	124
15 Transportation & Warehousing	0	1	0	3	5	71	0	3	0	83
16 Communication & Utilities	1	1	1	10	9	4	1	7	0	34
17 Wholesale Trade	0	1	1	1	1	3	1	0	0	8
18 Automobile Dealers & Gas Stations	0	40	0	2	23	100	0	9	0	174
19 Eating & Drinking Places	0	0	0	5	3	1	95	0	0	104
20 Other Retail Trade	1	10	21	15	8	8	7	8	0	78
21 Finance, Insurance, & Real Estate	0	4	19	5	0	0	12	0	0	40
22 Personal & Repair Service	1	2	0	3	6	10	30	2	0	54
23 Business & Professional Services	34	3	0	18	2	5	68	2	0	132
TOTAL	47	323	45	73	174	481	225	161	550	2079

* Spanish surname, Black, American Indian, and Oriental.

TABLE F-4

INDUSTRY-OCCUPATION MATRIX OF TOTAL EMPLOYED SEASONALLY* (1974)

Rio Grande Basin, Colorado

Sectors	Professional and Technical	Managers and Administrators	Sales	Clerical	Craftsmen, Foreman & Mechanics	Equipment Operators	Service Workers	Laborers Non-Farm	Farm Labor and Farm Foreman	Total
1 Livestock	0	0	0	0	0	0	0	0	515	515
2 Food Crops	0	1	2	6	11	19	0	52	1050	1141
3 Feed Crops	0	0	0	1	2	4	0	11	216	234
4 Truck Crops & Other Agriculture	0	0	2	1	1	1	0	3	59	67
5 Agricultural Services	5	25	0	5	0	390	0	56	0	481
6 Mining	0	0	0	0	0	0	0	0	0	0
7 Construction	0	0	0	9	130	25	0	36	0	200
8 Food & Kindred Products	0	5	0	1	0	77	0	10	0	93
9 Clothing, Leather, & Jewelry	0	0	0	0	0	0	0	0	0	0
10 Logging	0	0	0	0	0	0	0	0	0	0
11 Sawmills	0	0	0	0	0	0	0	0	0	0
12 Printing & Publishing	0	0	0	0	0	0	0	0	0	0
13 Agricultural Chemicals	0	0	0	0	0	0	0	0	0	0
14 Other Manufacturing	0	0	0	0	0	0	0	0	0	0
15 Transportation & Warehousing	0	0	0	0	0	0	0	0	0	0
16 Communication & Utilities	0	0	0	0	0	0	0	0	0	0
17 Wholesale Trade	0	0	0	0	0	7	0	2	0	9
18 Automobile Dealers & Gas Stations	0	0	0	9	0	50	0	9	0	68
19 Eating & Drinking Places	0	6	0	0	0	0	30	2	0	38
20 Other Retail Trade	0	0	0	0	0	0	0	0	0	0
21 Finance, Insurance, & Real Estate	0	23	50	26	12	12	7	10	0	140
22 Personal & Repair Service	0	0	0	0	0	0	0	0	0	44
23 Business & Professional Services	0	0	0	0	0	0	0	0	0	66
TOTAL	5	60	54	58	156	585	37	191	1840	3096

* Each job represents approximately one-third of a man-year.

Table F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Sales - $ Millions	Decade Midpoint	Future W/O	NED	Alternate	EQ
Agriculture - Direct		97.5	103.6	102.9	93.7
Indirect	2000	20.9	21.7	21.6	20.2
Induced		42.4	44.9	44.6	40.7
Total		160.8	170.2	169.1	154.6
Direct		103.5	114.0	109.7	100.1
Indirect	2020	22.0	23.3	22.7	21.4
Induced		45.4	49.9	47.8	43.9
Total		170.9	187.2	180.3	165.4
Forestry - Direct		9.0	10.5	9.3	7.1
Indirect	2000	3.6	4.4	3.7	2.6
Induced		6.3	7.3	6.6	5.1
Total		18.9	22.2	19.6	14.8
Direct		13.0	12.6	11.1	8.3
Indirect	2020	5.0	5.0	4.2	2.8
		9.2	8.9	8.0	6.2
		27.2	26.5	23.3	17.3

Table F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Sales - $ Millions		Decade Midpoint	Future W/O	NED	Alternate	EQ
Total -	Direct	2000	106.5	114.1	112.2	100.8
	Indirect		24.5	26.1	25.3	22.8
	Induced		48.7	52.2	51.2	45.8
	Total		179.7	192.4	188.7	169.4
	Direct	2020	116.5	126.6	120.8	108.4
	Indirect		27.0	28.3	26.9	24.2
	Induced		54.6	58.8	55.8	50.1
	Total		198.1	213.7	203.6	182.7

Table F-5

Sheet 3 of 10

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Gross Regional Product - $ Millions		Decade Midpoint	Future W/O	NED	Alternate	EQ
Agriculture	- Direct		59.4	62.4	62.0	57.0
	Indirect	2000	27.9	29.4	29.2	27.0
	Induced		37.9	40.0	39.8	36.3
	Total		125.2	131.8	131.0	120.3
	Direct		63.1	68.3	66.0	60.9
	Indirect	2020	29.8	32.2	31.0	28.7
	Induced		40.5	44.5	42.7	39.2
	Total		133.4	145.0	139.7	128.8
	Direct		5.5	6.4	5.8	4.5
	Indirect	2000	4.5	5.3	4.7	3.4
	Induced		5.7	6.6	5.9	4.6
	Total		15.7	18.3	16.4	12.5
	Direct		8.1	7.9	7.0	5.5
	Indirect	2020	6.4	6.2	5.5	3.9
	Induced		8.2	8.0	7.1	5.5
	Total		22.7	22.1	19.6	14.9

Table F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Gross Regional Product - $ Millions	Decade Midpoint	Future W/O	NED	Alternate	EQ
Total - Direct		64.9	68.8	67.8	61.5
Indirect	2000	32.4	34.7	33.9	30.4
Induced		43.6	46.6	45.7	40.9
Total		140.9	150.1	147.4	132.8
Direct		71.2	76.2	73.0	66.4
Indirect	2020	36.2	38.4	36.5	32.6
Induced		48.7	52.5	49.8	44.7
Total		156.1	167.1	159.3	143.7

Table F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Employment - Man Years	Decade Midpoint	Future W/O	NED	Alternate	EQ
Agriculture - Direct		3,400	3,600	3,600	3,300
Indirect	2000	2,300	2,400	2,300	2,100
Induced		2,500	2,700	2,700	2,400
Total		8,200	8,700	8,600	7,800
Direct		3,700	4,000	3,900	3,500
Indirect	2020	2,200	2,700	2,600	2,400
Induced		2,800	3,000	2,800	2,600
Total		8,700	9,700	9,300	8,500
Forestry - Direct		500	600	500	400
Indirect	2000	300	400	400	300
Induced		400	400	400	300
Total		1,200	1,400	1,300	1,000
Direct		700	700	600	500
Indirect	2020	600	500	400	300
Induced		500	500	500	400
Total		1,800	1,700	1,500	1,200

TABLE F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Employment - Man Years		Decade Midpoint	Future W/O	NED	Alternate	EQ
Total -	Direct		3,900	4,200	4,100	3,700
	Indirect	2000	2,600	2,800	2,700	2,400
	Induced		2,900	3,100	3,100	2,700
	Total		9,400	10,100	9,900	8,800
	Direct		4,400	4,700	4,500	4,000
	Indirect	2020	2,800	3,200	3,000	2,700
	Induced		3,300	3,500	3,300	3,000
	Total		10,500	11,400	10,800	9,700

TABLE F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Income - $ Millions		Decade Midpoint	Future W/O	NED	Alternate	EQ
Agriculture -	Direct		24.0	25.7	25.6	23.2
	Indirect	2000	16.4	17.1	16.9	15.7
	Induced		23.4	24.7	24.6	22.4
	Total		63.8	67.5	67.1	61.3
	Direct		25.6	28.3	27.3	24.8
	Indirect	2020	17.3	18.9	18.1	16.9
	Induced		25.1	27.5	26.3	24.2
	Total		68.0	74.7	71.7	65.9
Forestry -	Direct		3.7	4.2	3.6	2.9
	Indirect	2000	2.6	3.2	2.9	2.1
	Induced		3.5	4.0	3.6	2.8
	Total		9.8	11.4	10.1	7.8
	Direct		5.3	5.3	4.6	3.6
	Indirect	2020	3.8	3.6	3.2	2.2
	Induced		5.0	4.9	4.4	3.4
	Total		14.1	13.7	12.2	9.2

TABLE F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Income - $ Millions	Decade Midpoint	Future W/O	NED	Alternate	EQ
Total - Direct	2000	27.7	29.9	29.2	26.1
Indirect		19.0	20.3	19.8	17.8
Induced		26.9	28.7	28.2	25.2
Total		73.6	78.9	77.2	69.1
Direct	2020	30.9	33.5	31.9	28.4
Indirect		21.1	22.5	21.3	19.1
Induced		30.1	32.4	30.7	27.6
Total		82.1	88.4	83.9	75.1

TABLE F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Population - numbers		Decade Midpoint	Future W/O	NED	Alternate	EQ
Agriculture -	Direct	2000	11,000	11,600	11,600	10,700
	Indirect		7,400	7,700	7,400	6,800
	Induced		8,100	8,700	8,700	7,700
	Total		26,400	28,000	27,700	25,200
	Direct	2020	11,900	12,900	12,600	11,300
	Indirect		7,100	8,700	8,400	7,700
	Induced		9,000	9,700	9,000	8,400
	Total		28,000	31,300	30,000	27,400
Forestry -	Direct	2000	1,600	1,900	1,600	1,300
	Indirect		1,000	1,300	1,300	1,000
	Induced		1,300	1,300	1,300	1,000
	Total		3,900	4,500	4,200	3,300
	Direct	2020	2,300	2,300	1,900	1,600
	Indirect		1,900	1,600	1,300	1,000
	Induced		1,600	1,600	1,600	1,300
	Total		5,800	5,500	4,800	3,900

TABLE F-5

REGIONAL DEVELOPMENT ACCOUNT

EFFECTS OF FUTURE WITHOUT PLAN AND ALTERNATIVE PLANS

Rio Grande Basin, Colorado

OBERS E' SCENARIO

Effects of Agriculture and Forestry Production

Population - numbers		Decade Midpoint	Future W/O	NED	Alternate	EQ
Total -	Direct	2000	12,600	13,500	13,200	11,900
	Indirect		8,300	9,000	8,700	7,700
	Induced		9,400	10,000	10,000	8,700
	Total		30,300	32,500	31,900	28,300
	Direct	2020	14,200	15,200	14,500	12,900
	Indirect		9,000	10,300	9,700	8,700
	Induced		10,600	11,300	10,600	9,700
	Total		33,800	36,800	34,800	31,300

Table F-6 Summary of Employment Effects
Total Employment Effects

Rio Grande Basin, Colorado

Year and plan	Professional and technical	Managers and administration	Sales	Clerical	Craft foreman mechanics	Equipment operators	Service workers	Laborers non-farm	Farm labor and foreman	TOTAL
				(number of employees)						
2000										
FW	818	3,782	893	1,212	1,212	1,522	1,465	842	2,117	13,863
NED	834	3,901	913	1,238	1,256	1,585	1,501	871	2,181	14,280
Alternative	830	3,880	908	1,230	1,233	1,549	1,490	853	2,174	14,147
EQ	804	3,690	877	1,188	1,168	1,455	1,432	809	2,069	13,492
2020										
FW	848	3,959	933	1,264	1,294	1,642	1,561	895	2,195	14,591
NED	870	4,146	959	1,294	1,317	1,665	1,603	902	2,304	15,050
Alternative	855	4,046	942	1,271	1,278	1,607	1,571	874	2,254	14,698
EQ	828	3,850	909	1,227	1,203	1,498	1,509	822	2,150	13,996

Table F-6 Summary of Employment Effects
Women Employed

Sheet 2 of 4

Rio Grande Basin, Colorado

Year and plan	Professional and technical	Managers and administration	Sales	Clerical	Craft foreman mechanics	Equipment operators	Service workers	Laborers non-farm	Farm labor and foreman	TOTAL
				(number of women)						
2000										
FW	311	176	388	929	129	318	1,005	25	0	3,281
NED	317	180	397	949	131	323	1,029	26	0	3,352
Alternative	316	179	395	943	131	322	1,022	26	0	3,334
EQ	305	172	381	911	127	313	984	25	0	3,218
2020										
FW	323	185	408	970	134	329	1,072	27	0	3,448
NED	331	192	419	994	136	335	1,101	27	0	3,535
Alternative	325	188	412	976	134	330	1,080	27	0	3,472
EQ	314	181	396	941	131	321	1,040	26	0	3,350

Table F-6 Summary of Employment Effects
Minorities Employed

Sheet 3 of 4

Rio Grande Basin, Colorado

Year and plan	Professional and technical	Managers and administration	Sales	Clerical	Craft foreman mechanics	Equipment operators	Service workers	Laborers non-farm	Farm labor and foreman	TOTAL
				(number of persons)						
2000										
FW	68	722	69	109	266	743	372	266	1,350	3,965
NED	69	749	70	112	278	790	383	286	1,404	4,131
Alternative	69	746	70	111	270	756	379	271	1,399	4,071
EQ	67	705	68	106	252	703	362	243	1,315	3,821
2020										
FW	70	758	72	115	288	811	400	301	1,417	4,232
NED	72	809	74	118	291	818	410	300	1,523	4,415
Alternative	71	786	72	115	280	783	400	281	1,475	4,263
EQ	68	743	70	110	259	719	381	245	1,390	3,985

Table F-6 Summary of Employment Effects
Seasonal Employment

Sheet 4 of 4

Rio Grande Basin, Colorado

Year and plan	Professional and technical	Managers and administration	Sales	Clerical	Craft foreman mechanics	Equipment operators	Service workers	Laborers non-farm	Farm labor and foreman	TOTAL
				(number of persons)						
2000										
FW	13	112	75	93	223	1,263	64	401	4,358	6,602
NED	13	114	76	95	227	1,288	66	413	4,522	6,814
Alternative	13	113	76	95	226	1,286	65	412	4,506	6,792
EQ	12	110	74	92	219	1,214	63	393	4,249	6,453
2020										
FW	13	116	77	97	230	1,310	69	419	4,560	6,891
NED	14	120	79	100	237	1,363	71	443	4,873	7,300
Alternative	13	117	78	98	233	1,334	69	431	4,730	7,103
EQ	13	114	76	95	225	1,291	67	412	4,472	6,765

APPENDIX G

PROJECTS

APPENDIX G

CONTENTS

FIGURE

PROJECTS

The following project descriptions are for implemented (ongoing) early action and long-term projects in the Rio Grande Basin. The implemented projects are presently funded for construction or may already be under construction. The early action and long-term projects were those considered in the three plans - National Economic Development Plan, Alternate Plan, and Environmental Quality Plan. (See Figure G-1)

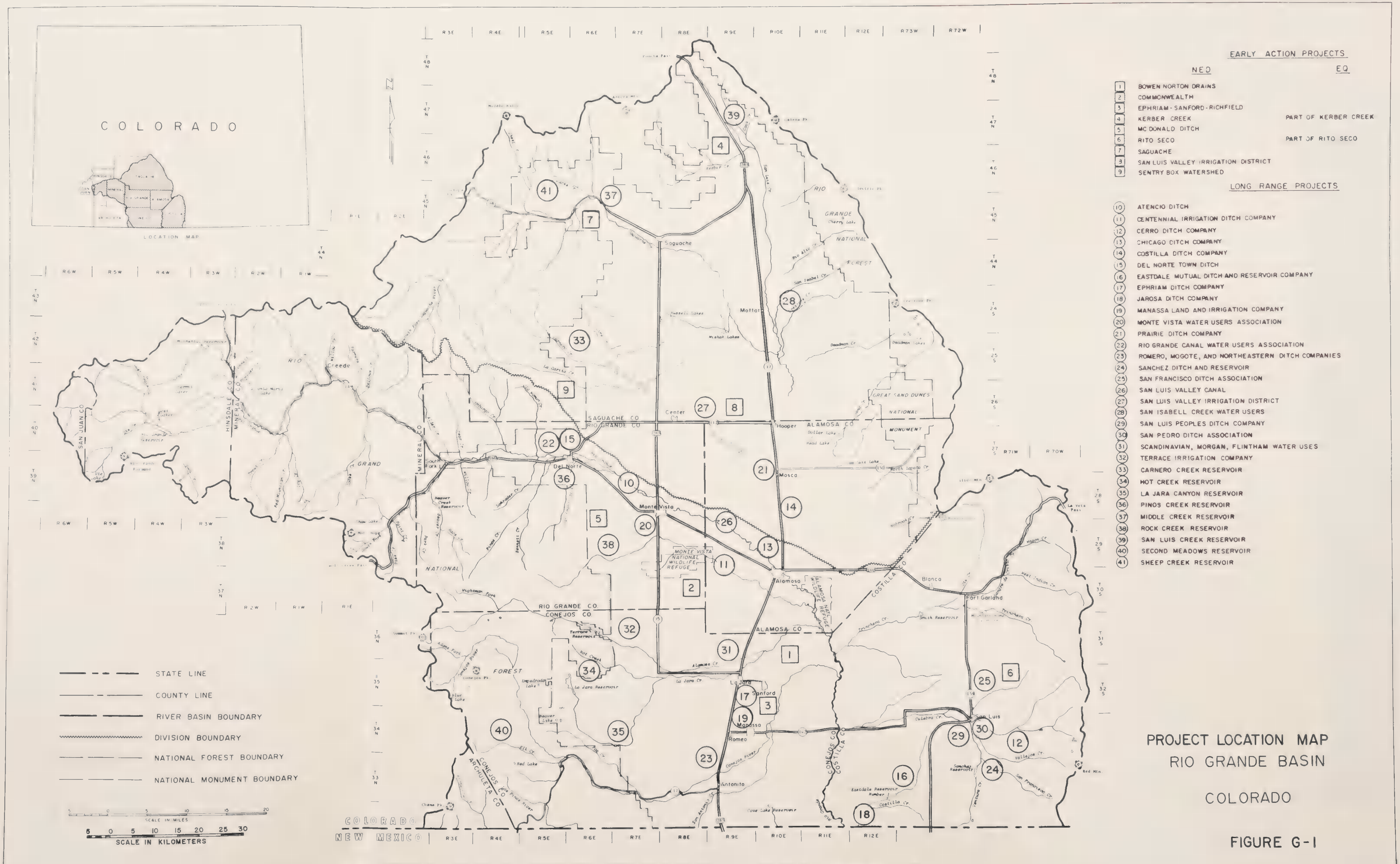
Implemented (Ongoing) Projects

Closed Basin Division - San Luis Valley Project, Colorado - This project is a Bureau of Reclamation, Department of the Interior, project. This project is a multiple-purpose water resource development which will salvage shallow ground water now non-beneficially consumed in the Closed Basin portion of the Rio Grande Basin and deliver it to the Rio Grande for beneficial use in accordance with the Rio Grande Compact among the states of Colorado, New Mexico, and Texas. A small portion of the water salvaged would also be made available to the Alamosa National Wildlife Refuge.

The water salvage plan includes the following features: (1) about 129 wells and pumping plants, (2) 44 miles (71 km) of main conveyance channel, (3) 0.5 mile (0.8 km)of connecting channel, (4) 11 miles (18 km) of east side conveyance channel, (5) 92 miles (148 km) of field laterals, (6) road and railroad bridges and (7) recreational facilities at San luis Lake, and the Mishak Lakes National Wildlife Refuge is to be developed.

Del Norte Recreation Measure - This project is a San Luis Valley RC&D measure. The objective of the project is to provide adequate water based recreation facilities for tourists and local residents. Works of improvement include: restrooms, water fountains, shelters, picnic tables, barbeque grills, trash cans, vehicle barriers, pedestrian bridges, security lights, drain ditch conduit, water and sewerline extension, parking area, sprinkler system extension, shaping, grading and reseeding.

Trinchera Watershed - This project is a PL-566 Agricultural Water Management project. The objective of this project is to improve irrigation water management on farms, decrease canal seepage losses, and replace deteriorated control structures. Irrigated lands total 11,450 acres (4,634 ha) with approximately 1,800 (idle acres) (728 ha) of this total not farmed yearly. The structural programs includes: concrete lining of approximately 12.6 miles (20 km) of canal, realignment of short reaches of canal, replacement of turnouts, and water control structures.


EARLY ACTION PROJECTS
NED
EQ
1 BOWEN NORTON DRAINS
2 COMMONWEALTH
3 EPHRIAM-SANFORD-RICHFIELD
4 KERBER CREEK
PART OF KERBER CREEK
5 MC DONALD DITCH
6 RITO SECO
PART OF RITO SECO
7 SAGUACHE
8 SAN LUIS VALLEY IRRIGATION DISTRICT
9 SENTRY BOX WATERSHED
LONG RANGE PROJECTS
10 ATENCIO DITCH
11 CENTENNIAL IRRIGATION DITCH COMPANY
12 CERRO DITCH COMPANY
13 CHICAGO DITCH COMPANY
14 COSTILLA DITCH COMPANY
15 DEL NORTE TOWN DITCH
16 EASTDALE MUTUAL DITCH AND RESERVOIR COMPANY
17 EPHRIAM DITCH COMPANY
18 JAROSA DITCH COMPANY
19 MANASSA LAND AND IRRIGATION COMPANY
20 MONTE VISTA WATER USERS ASSOCIATION
21 PRAIRIE DITCH COMPANY
22 RIO GRANDE CANAL WATER USERS ASSOCIATION
23 ROMERO, MOGOTE, AND NORTHEASTERN DITCH COMPANIES
24 SANCHEZ DITCH AND RESERVOIR
25 SAN FRANCISCO DITCH ASSOCIATION
26 SAN LUIS VALLEY CANAL
27 SAN LUIS VALLEY IRRIGATION DISTRICT
28 SAN ISABELL CREEK WATER USERS
29 SAN LUIS PEOPLES DITCH COMPANY
30 SAN PEDRO DITCH ASSOCIATION
31 SCANDINAVIAN, MORGAN, FLINTHAM WATER USES
32 TERRACE IRRIGATION COMPANY
33 CARNERO CREEK RESERVOIR
34 HOT CREEK RESERVOIR
35 LA JARA CANYON RESERVOIR
36 PINOS CREEK RESERVOIR
37 MIDDLE CREEK RESERVOIR
38 ROCK CREEK RESERVOIR
39 SAN LUIS CREEK RESERVOIR
40 SECOND MEADOWS RESERVOIR
41 SHEEP CREEK RESERVOIR
COLORADO
LOCATION MAP
STATE LINE
COUNTY LINE
RIVER BASIN BOUNDARY
DIVISION BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL MONUMENT BOUNDARY
SCALE IN MILES
SCALE IN KILOMETERS
SAGUACHE CO
RIO GRANDE CO
ALAMOSA CO
CONEJOS CO
COSTILLA CO
ARCHULETA CO
MINERAL CO
HINSDALE CO
SAN JUAN CO
Saguache
Center
Hooper
Mosca
Del Norte
Monte Vista
Alamosa
Blanco
Fort Garland
La Jara
Sanford
Manassa
Romeo
Antonito
San Luis
Creede
Moffat
MONTE VISTA NATIONAL WILDLIFE REFUGE
ALAMOSA NATIONAL WILDLIFE REFUGE
GREAT SAND DUNES NATIONAL MONUMENT
RIO GRANDE NATIONAL FOREST
COLORADO
NEW MEXICO
PROJECT LOCATION MAP
RIO GRANDE BASIN
COLORADO
FIGURE G-1

Early Action Projects

Bowen and Norton Drain - There are 22,500 acres (9,106 ha) of irrigated land served by the Bowen and Norton Drainage Districts. The Bowen Drain serves 11,500 acres (4,654 ha) and needs approximately 4 miles (6.4 km) of drain tile replaced along with 130 structures, new or replaced. The Norton Drainage District serves 11,000 acres (4,452 ha) and needs approximately 10 miles (16.1 km) of new open drains added to the systems.

These two drainage systems serve as drainage outlets for the area southwest of the Rio Grande. Estimated installation cost on the area served by these drains is $3,831,800.

Commonwealth - There are approximately 48,000 acres (19,426 ha) of irrigated land served by the Commonwealth Irrigation Company. Improvement needs on this system consist of canal and ditch lining, turnout, measuring and diversion structure at an estimated cost of $476,700.

Ephriam, Sanford, Richfield - There are approximately 14,200 acres (5,747 ha) of irrigated land served by the Ephriam Ditch, Sanford Ditch, and Richfield Canal. These three delivery systems divert water from the Conejos and San Antonio Rivers at approximately the same locations and run parallel for 1.5 miles. (2.4 km) Improvement needs include combining these systems for 1.5 miles (2.4 km) along with ditch lining and other canal structures. Estimated installation cost on these systems is $703,700.

Kerber Creek Watershed - There are approximately 2,400 acres (971 ha) of irrigated land served by Kerber Creek. Kerber Creek is a potential project involving stabilization of critical erosion areas (mine tailings), agricultural water management and flood control. The watershed is about 20 miles (32 km) long and 7 miles (11 km) in width with an area of 121 square miles (313 km^2).

The proposed works of improvement for agricultural water management and flood control purposes include an off channel reservoir, diversion canal, and irrigation water control facilities.

The proposed off channel reservoir would have a capacity of 2,155 acre-feet (2,658,193 m^3) for late season irrigation use, 45 acre-feet (55,508 m^3) for sediment storage, and 300 acre-feet (370,050 m^3) for detention storage. Structural measures proposed for stabilization of critical erosion areas (mine tailings) are:

(1) Diversions and conduits to transport Squirrel Creek and Rawley Gulch past mine tailings.

(2) Three miles (4.8 km) of channel resectioning, rip-rapping, shaping and vegetation of mine tailing areas along Kerber Creek. The estimated installation cost is $2,299,400.

McDonald Ditch - There are approximately 1,700 acres (688 ha) of irrigated land served by McDonald Ditch. Improvement needs on this system consist of: concrete ditch lining for 5,300 feet (1,615 m) of main canal, and 9,200 feet (2,804 m) of lateral, a concrete weir in the main canal, a steel pipe flume, and new metal rectangular gates and water control structures. The estimated installation cost is $151,000.

Rito Seco Watershed - Rito Seco is a potential project involving flood prevention, primarily to the town of San Luis and adjacent farm land, and stabilization of erosion areas in the watershed. Improvement needs in the watershed consist of: A class I dike approximately 2.7 miles (4.3 km) long and 10 critically eroded areas will be treated with structural measures. The estimated installation cost is $787,300. Additional critically eroded areas will be treated with a land treatment program with an estimated cost of $994,600.

Saguache Watershed - The Saguache Watershed is a potential project involving flood prevention and irrigation water management. The reservoir would have a capacity of 9,000 acre-feet (11,101,500 m^3) for late season irrigation use, 750 acre-feet (925,125 m^3) for sediment storage, and 5,500 acre-feet (678,425 m^3) for detention storage. There are 14,000 acres (5,666 ha) of irrigated lands served by Saguache Creek. Estimated installation cost is $4,117,500.

San Luis Valley Irrigation District - There are 44,000 acres (17,807 ha) of irrigated land served by the San Luis Valley Irrigation District. Improvement needs are listed as follows:

(1) Repair of emergency spillway on Rio Grande Reservoir.

(2) Install linings on Farmers Union Canal.

(3) Install linings on Hiline Lateral.

(4) Repair gates at the Rio Grande Reservoir.

(5) Replace standpipe gage at the Rio Grande Reservoir.

(6) Replace water control structures where needed within system.

(7) Construct two regulating storage reservoirs on the east side of the Irrigation District to aid in irrigation water delivery.

(8) Construction of an outlet drain in the east side of the irrigation system.

Estimated installation cost is $702,000.

Sentry Box Watershed - The Sentry Box Watershed includes 82 square miles (212 km^2) of La Garita Creek. The project is a multiple-purpose dam and reservoir for flood prevention. The reservoir would have a capacity of 6,895 acre-feet, (8,504,983 m^3) which is as follows: 350 acre-feet (431,725 m^3) for sediment, 400 acre-feet (493,400 m^3) for mitigated wildlife water, 5,500 acre-feet (6,784,250 m^3) for irrigation, and 645 acre-feet (795,608 m^3) for flood prevention. Estimated installation cost is $4,640,500.

Long Range Projects

Atencio Ditch - There are 400 acres (162 ha) of irrigated land served by Atencio Ditch. Improvement needs on this system consist of 5 turnouts and one wasteway to improve the delivery system. The estimated installation cost is $21,400.

Centennial Irrigation Ditch Company - There are 9,120 acres (3,691 ha) of irrigated land served by Centennial Irrigation Ditch Company. Improvement needs on this system consist of 1.4 miles (2.3 km) of concrete lining, 28 turnouts, 17 check structures and one flume to improve the delivery system. The estimated installation cost is $461,100.

Cerro Ditch Company - There are 2,100 acres (850 ha) of irrigated land served by Cerro Ditch Company. Improvement needs on this system consist of 2 miles (3.2 km) of canal realignment, 139 turnouts, one check structure, one flume and one wasteway to improve the delivery system. The estimated installation cost is $113,000.

Chicago Ditch Company - 4,224 acres (1,709 ha) of irrigated land are served by the Chicago Ditch Company. Improvement needs on this system consist of 0.5 mile (0.8 km) of canal realignment, one measuring structure, one flume and one wasteway to improve the delivery system. The estimated installation cost is $212,400.

Costilla Ditch Company - 7,240 acres (2,930 ha) of irrigated land are served by the Costilla Ditch Company. Improvement needs on this system consist of 5 turnouts to improve the delivery system. The estimated installation cost is $370,900.

Del Norte Town Ditch - 122 acres (49 ha) of irrigated land are served by the Del Norte Town Ditch. Improvement needs on this system consist of 1.4 miles (2.3 km) of closed conduit for safety purposes and reduced seepage losses through Del Norte. The estimated installation cost is $403,000.

Eastdale Mutual Ditch and Reservoir Company - 500 acres (202 ha) of irrigated land are served by Eastdale Mutual Ditch Company. Improvement needs on this system consist of 13 miles (21 km) underground

irrigation pipeline, 9 turnouts, and one flume to improve the delivery system. The estimated installation cost is $1,317,200.

Ephriam Ditch Company - There are 1,000 acres (405 ha) of irrigated land served by Ephriam Ditch Company. Improvement needs consist of 0.5 mile (0.8 km) of canal lining, and 23 turnouts to improve the delivery system. The estimated installation cost is $54,000.

Jarosa Ditch Company - 2,500 acres (1,812 ha) of irrigated land are served by Jarosa Ditch Company. Improvement needs consist of one mile (1.6 km) canal lining and a new diversion structure to improve the delivery system. The estimated installation cost is $74,900.

Manassa Land and Irrigation Company - There are 18,000 acres (7,285 ha) of irrigated land served by Manassa Irrigation Company. Improvement needs consist of 8.5 miles (13.7 km) of canal lining, 75 turnouts, 4 measuring structures, 1 flume, 2 siphons, and 2 wasteways to improve the delivery system. The estimated installation cost is $943,000.

Monte Vista Water Users Association - There are 28,100 acres (11,372 ha) of irrigated land served by Monte Vista Water Users Association. Improvement needs consist of 3.6 miles (5.8 km) of canal lining, 2 turnouts, and 8 water measuring structures to improve the delivery system. The estimated installation cost is $1,412,800.

Prairie Ditch Company - There are 21,100 acres (8,539 ha) of irrigated land served by Prairie Ditch Company. Improvement needs consist of 34 miles (54.7 km) of canal lining, 2 turnouts, 1 water measuring structure, 8 check structures, and 1 flume to improve the delivery system. The estimated installation cost is $1,106,400.

Rio Grande Canal Water Users Association - 118,000 acres (47,755 ha) of irrigated land are served by the Rio Grande Water Users Association. Improvement needs consist of 5.6 miles (9 km) of canal lining, 16 turnouts, 4 water measuring structures, 9 check structures, and 2 wasteways to improve the delivery system. The estimated installation cost is $5,944,100.

Romero, Mogote, and Northeastern Ditch Companies - There are 28,100 acres (11,372 ha) of irrigated land served by these ditch companies. Improvement needs consist of 10 miles (16.1 km) canal lining, 57 turnouts, and 3 water measuring structures to improve the delivery system. The estimated installation cost is $786,400.

Sanchez Ditch and Reservoir - There are 15,000 acres (6,071 ha) of irrigated land served by Sanchez Ditch. Improvement needs consist of 34 miles (55 km) of canal lining, 40 turnouts, 20 water measuring structures, 2 check structures, and 1 flume to improve the delivery system. The estimated installation cost is $788,700.

San Francisco Ditch Association - 1,080 acres (437 ha) of irrigated land are served by the San Francisco Ditch. Improvement needs consist of 2 miles (3.2 km) of canal lining, 5 turnouts, 2 flumes and 1 wasteway to improve the delivery system. The estimated installation cost is $62,300.

San Luis Valley Canal - There are 35,000 acres (14,165 ha) of irrigated land served by San Luis Valley Canal. Improvement needs consist of 21.5 miles (34.6 km) of canal lining, 100 turnouts, 66 water measuring structures, 27 check structures and 3 flumes to improve the delivery system. The estimated installation cost is $1,756,300.

San Luis Valley Irrigation District - There are 5,000 acres (2,024 ha) of irrigated land served by this canal. Improvement needs consist of 55 turnouts and 55 check structures to improve the delivery system. The estimated installation cost is $251,200.

San Isabell Creek Water Users - 900 acres (364 ha) of irrigated land are served by the San Isabell Ditch. Improvement needs consist of 6.3 miles (10.1 km) of canal lining, 5 turnouts, 2 water measuring structures, and 6 flumes to improve the delivery system. The estimated installation cost is $49,800.

San Luis Peoples Ditch Company - 1,625 acres (658 ha) of irrigated land are served by the San Luis Peoples Ditch. Improvement needs consist of 12 miles (19.3 km) of canal lining, 48 turnouts, 6 water measuring structures, and 2 wasteways to improve the delivery system. The estimated installation cost is $102,000.

San Pedro Ditch Association - There are 1,250 acres (506 ha) of irrigated land served by San Pedro Ditch. Improvement needs consist of 1.8 miles (2.9 km) of ditch lining, and 39 turnouts to improve the delivery system. The estimated installation cost is $67,000.

Scandinavian, Morgan, Flintham Water Users - There are 8,510 acres (3,444 ha) of irrigated land served by this ditch. Improvement needs consist of combining 2.0 miles (3.2 km) of these systems into one canal, along with 2 miles (3.2 km) of lining, 11 turnouts, 1 water measuring structure, 1 flume, and 1 siphon to improve the delivery system. The estimated cost is $428,600.

Terrace Irrigation Company - 10,995 acres (4,450 ha) of irrigated land are served by Terrace Irrigation Company. Improvement needs consist of 9 miles (14.5 km) of canal lining, 10 miles (16.1 km) of underground irrigation pipeline, 25 turnouts, and 10 check structures to improve the delivery system. The estimated cost is $562,800.

Carnero Creek Reservoir - The Carnero Creek Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 13,975 ac. ft. (17,238,163 m^3). The estimated installation cost is $6,852,300.

Hot Creek Reservoir - The Hot Creek Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 2,470 ac. ft. (3,046,745 m^3). The estimated installation cost is $1,352,300.

LaJara Canyon Reservoir - La Jara Canyon Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 9,600 ac. ft. (11,841,600 m^3). The estimated installation cost is $4,709,300.

Pinos Creek Reservoir - Pinos Creek Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 9,340 ac. ft. (11,520,890 m^3). The estimated installation cost is $4,606,000.

Middle Creek Reservoir - Middle Creek Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 7,888 ac. ft. (9,729,848 m^3). The estimated installation cost is $4,038,800.

Rock Creek Reservoir - Rock Creek Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 3,820 ac. ft. (4,711,970 m^3). The estimated installation cost is $1,875,600.

San Luis Creek Reservoir - San Luis Creek Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 6,670 ac. ft. (8,227,445 m^3). The estimated installation cost is $3,434,400.

Second Meadows Reservoir - Second Meadows Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 14,150 ac. ft. (17,454,025 m^3). The estimated installation cost is $6,836,000.

Sheep Creek Reservoir - Sheep Creek Reservoir is a potential multi-purpose reservoir with irrigation water management and flood control storage. The total storage capacity is 9,050 ac. ft. (11,163,157 m^3). The estimated installation cost is $4,474,400.

APPENDIX H

FOREST AND WILDERNESS

APPENDIX H

CONTENTS

FIGURES

TABLES

TIMBER PROCESSING AND UTILIZATION

Figures H-1 through H-4 show the projected timber yields by plan for each ownership. By projecting yields to 24 decades, sustained-yield timber management is assured. This policy was strictly adhered to on all public ownerships with their respective graph lines in the figures indicating a continuous upward trend. Production values actually may be higher in some decades than shown by a constant production line throughout a period of time on the graph because this line represents minimum production capability throughout that particular period. On private lands sustained-yield management was not assumed, the actual production values for each decade being graphed and the respective graph lines being more erratic and not necessarily having an upward tendency.

These figures also depict some of the characteristics of the forest resource in the basin. For example, the tendency for the national forest curve to lag between the 6th and 13th decades, especially when harvesting is high in earlier decades as in the NED and ALT Plans, can be attributed to the large current reforestation backlog. By planting these acres in the immediate future, over a century is required for these trees to attain a harvestable volume and, therefore, a relatively large rise in volume shown on the graph occurs in that time frame. Since Future Without Plan harvest volumes are lower in the early decades, some mature timber is carried over to later decades and, consequently, the lag is not as pronounced.

Increasing the production of merchantable products per acre harvested involves both in-woods utilization and sawmill efficiency. Sawmill efficiency involves producing more marketable products from a given piece of timber by increasing the precision of the equipment, reducing saw kerf and slab waste, and making optimum cuts. Based on USDA Forest Service Region 2 data, these recovery factors (RF) and lumber recovery factors (LRF) are used in the analysis:

	RF	LRF
Current sawmill practices	1.47	7.22
Improved sawmill practices	1.68	8.25
Optimum sawmill practices	1.85	9.09

The RF, frequently referred to as "overrun", represents the proportion of number of board feet lumber tally to board feet log scale, while the LRF is a proportion of board feet lumber tally to cubic feet log scale.

Table H-4 gives annual lumber production according to each of these levels of sawmill efficiency with current in-woods utilization.

In-woods utilization, in terms of the smallest tree cut and using more of each tree cut, was available for the following two levels of utilization.

TIMBER PRODUCTION UNDER FUTURE WITHOUT CONDITION
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Rio Grande Basin Colorado

Legend: F = National Forest B = Natural Resource Lands
S = State P = Private

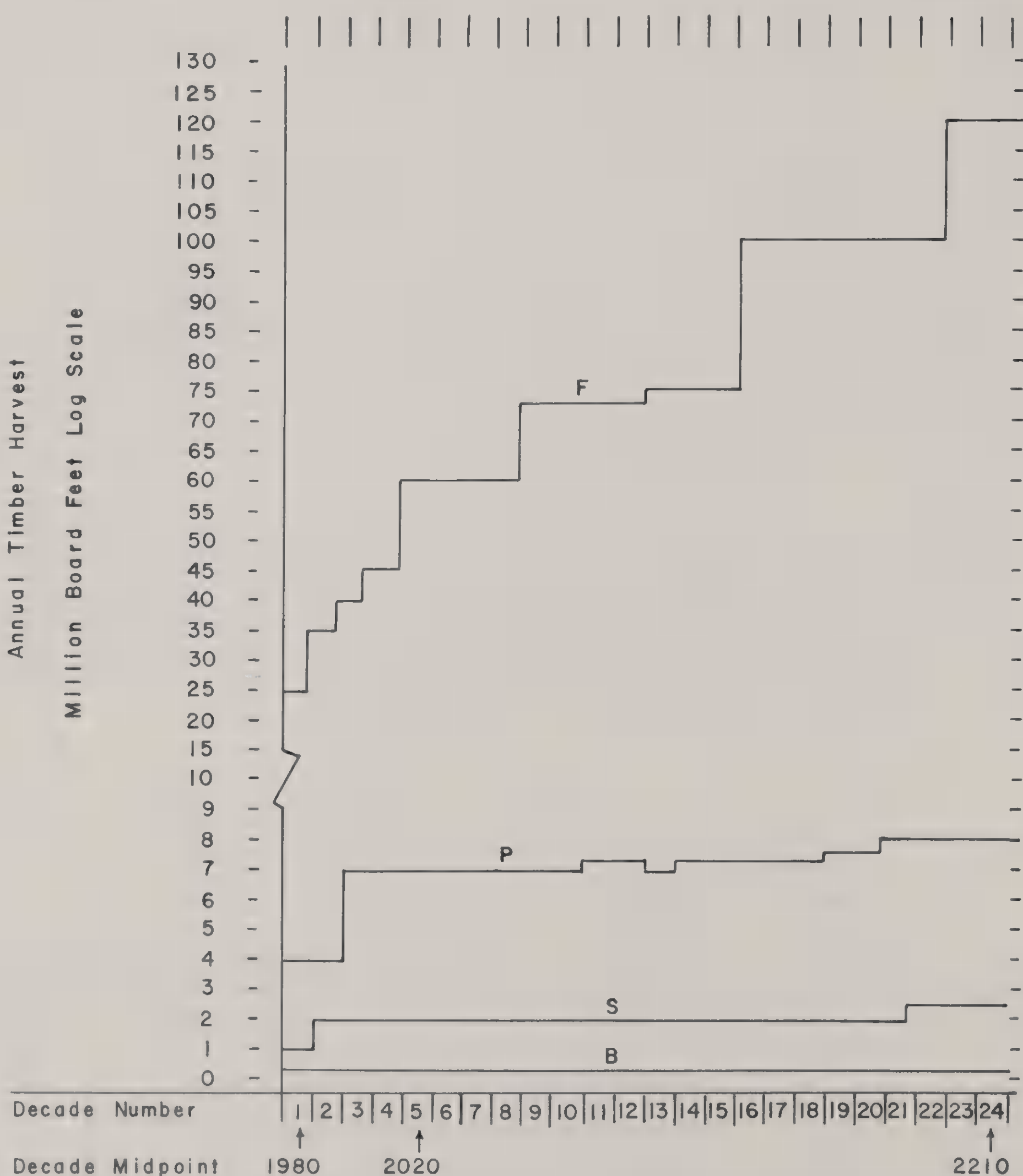


FIGURE H-1

TIMBER PRODUCTION UNDER NATIONAL ECONOMIC DEVELOPMENT PLAN
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Rio Grande Basin Colorado

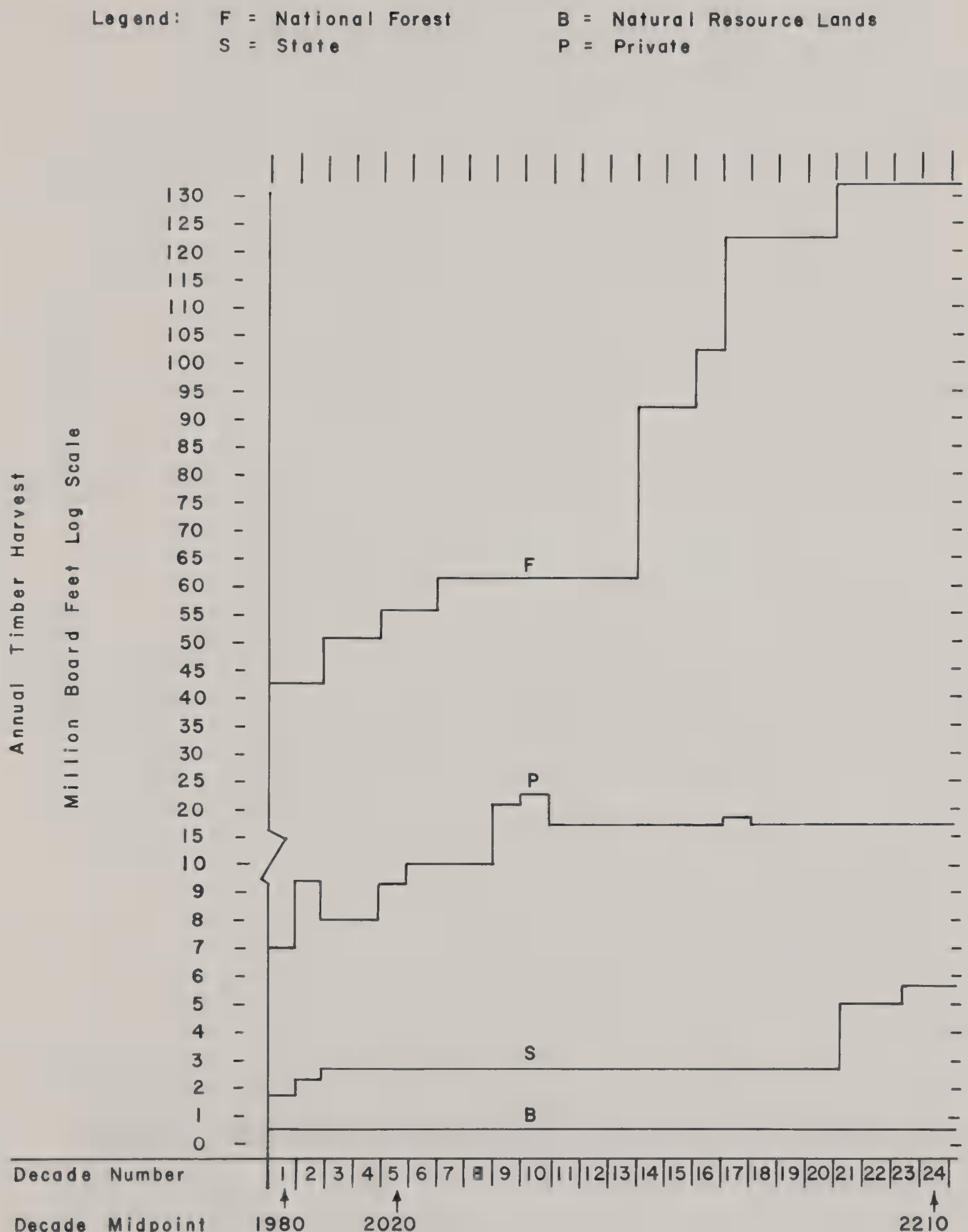


FIGURE H-2

TIMBER PRODUCTION UNDER ALTERNATE PLAN
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Rio Grande Basin Colorado

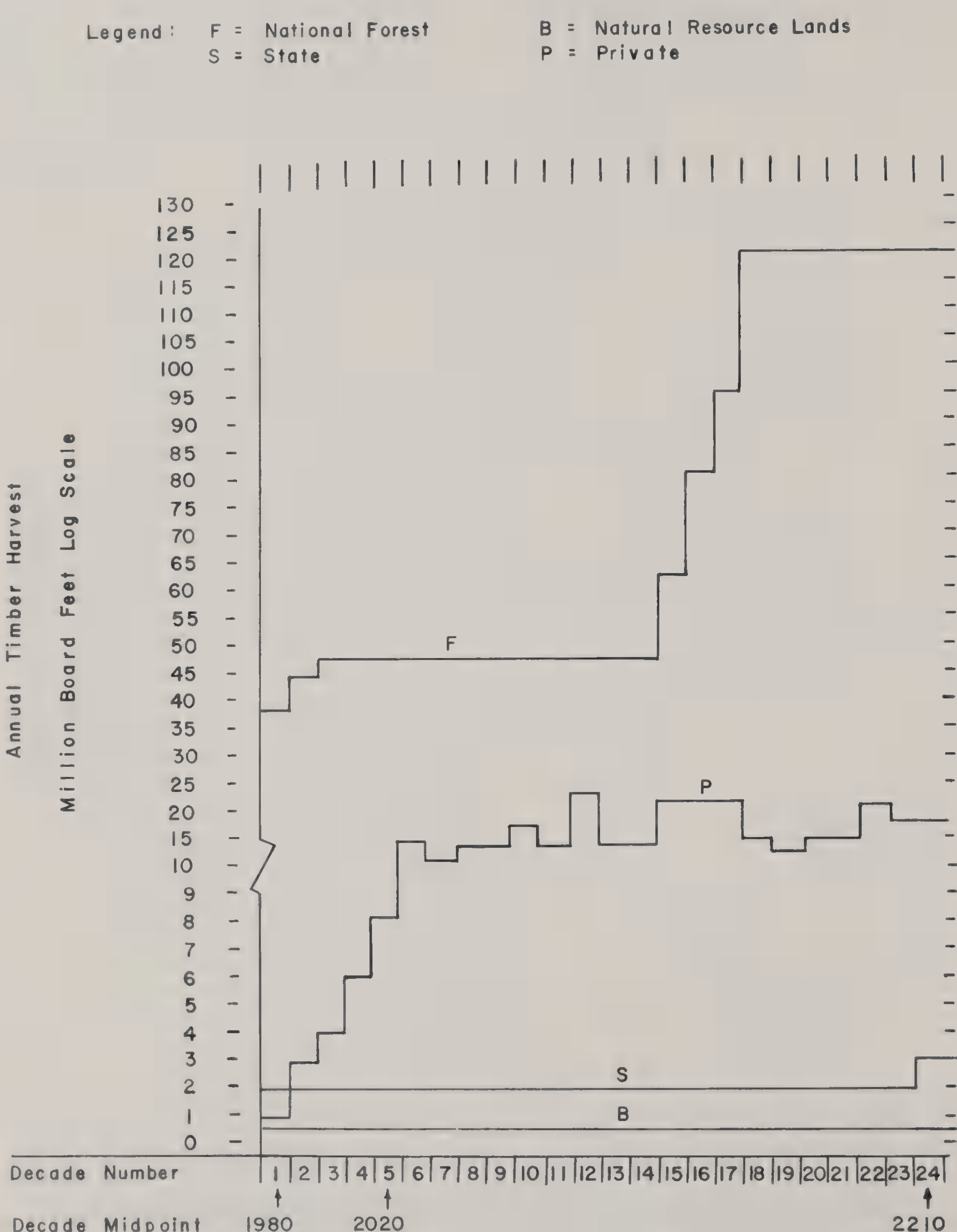


FIGURE H-3

TIMBER PRODUCTION UNDER ENVIRONMENTAL QUALITY PLAN
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Rio Grande Basin Colorado

Legend: F = National Forest B = Natural Resource Land
S = State P = Private

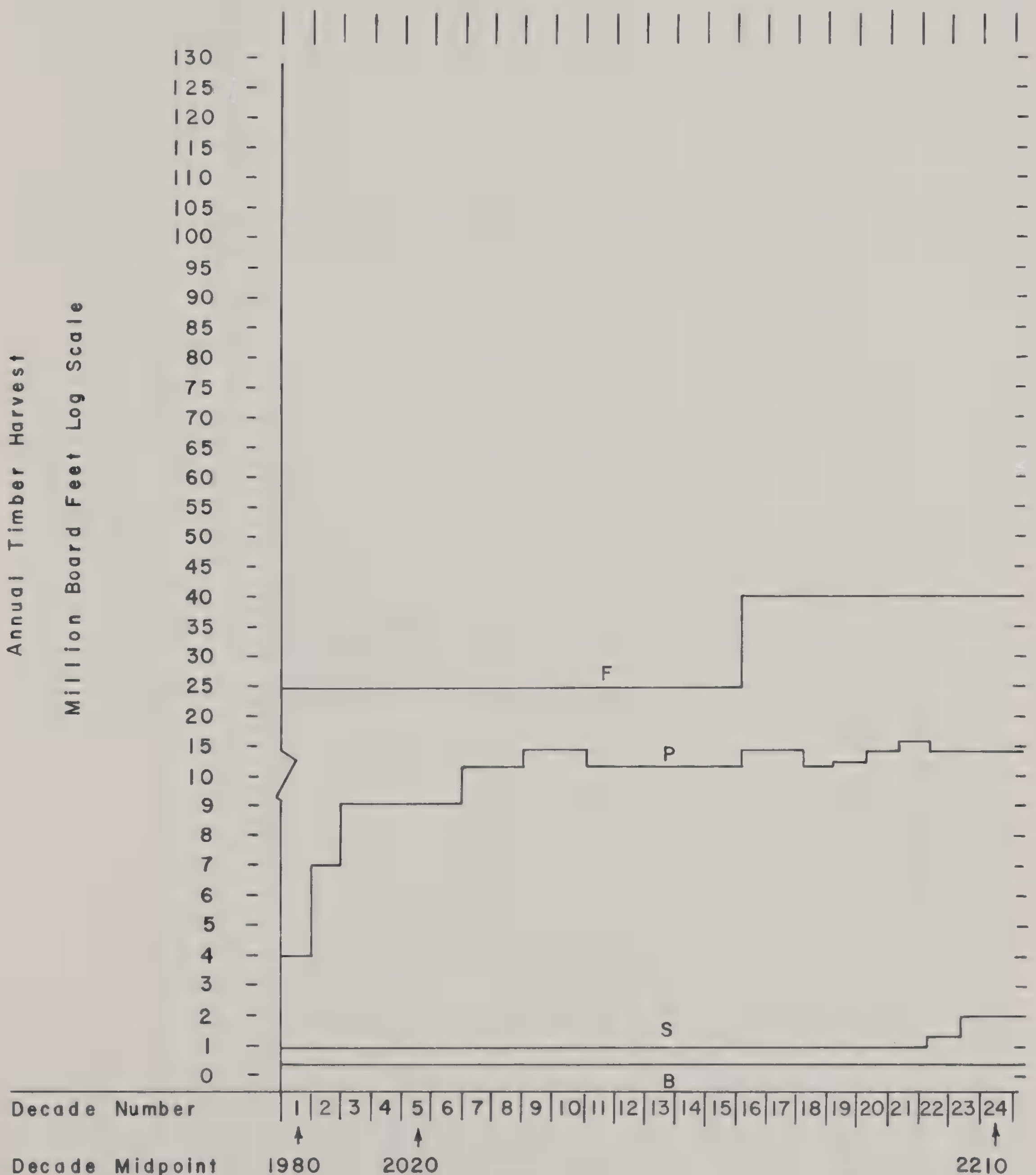


FIGURE H-4

TABLE H-1

Federal and Forest Lands
Effects of Plans on National Economic Development Account
Rio Grande Basin Colorado

	Annual Timber Harvest - Million Board Feet Log Scale				
Ownership	Decade Midpoint	FW	NED	ALT	EQ
Forest Service	1980	25.0	42.0	38.5	25.0
	1990	35.0	42.0	43.8	25.0
	2000	40.0	50.0	45.5	25.0
	2010	45.0	50.0	45.5	25.0
	2020	60.0	55.0	45.5	25.0
Bureau of Land Management	1980	0.5	0.5	0.5	0.3
	1990	0.5	0.5	0.5	0.3
	2000	0.5	0.5	0.5	0.3
	2010	0.5	0.5	0.5	0.3
	2020	0.5	0.5	0.5	0.3
State & Private Mixed	1980	1.0	1.8	1.0	1.0
	1990	2.0	2.3	2.0	1.0
	2000	2.0	2.5	2.0	1.0
	2010	2.0	2.5	2.0	1.0
	2020	2.0	2.5	2.0	1.0
Private Only	1980	4.0	7.0	2.0	4.0
	1990	4.0	9.4	3.0	7.0
	2000	7.0	8.0	4.0	9.0
	2010	7.0	8.0	6.0	9.0
	2020	7.0	9.3	8.0	9.0
Total - All Ownerships	1980	30.5	51.3	42.0	30.3
	1990	41.5	54.2	49.3	33.3
	2000	49.5	61.0	52.0	35.3
	2010	54.5	61.0	54.0	35.3
	2020	69.5	67.3	56.0	35.3

TABLE H-2

Federal and Forest Lands
Effects of Plans on National Economic Development Account
Rio Grande Basin Colorado

Stocking Control Initiated (Thinning) - Acres Per Decade (Hectares)

Ownership	Decade Midpoint	FW	NED	ALT	EQ
Forest Service	1980	45,082 (18,215)	36,314 (14,696)	23,146 (9,367)	5,290 (2,141)
	1990	2,250 (911)	16,197 (6,555)	6,083 (2,462)	0 (0)
	2000	0 (0)	3,613 (1,462)	766 (310)	0 (0)
	2010	0 (0)	0 (0)	12,405 (5,050)	2,767 (1,120)
	2020	6,844 (2,780)	5,940 (2,404)	9,343 (3,781)	0 (0)
Bureau of Land Management	1980	0 (0)	0 (0)	0 (0)	0 (0)
	1990	0 (0)	0 (0)	80 (32)	0 (0)
	2000	0 (0)	0 (0)	0 (0)	0 (0)
	2010	0 (0)	0 (0)	0 (0)	0 (0)
	2020	0 (0)	0 (0)	0 (0)	0 (0)
State & Private Mixed	1980	0 (0)	0 (0)	0 (0)	0 (0)
	1990	80 (32)	80 (32)	0 (0)	0 (0)
	2000	0 (0)	0 (0)	0 (0)	0 (0)
	2010	0 (0)	0 (0)	0 (0)	0 (0)
	2020	0 (0)	0 (0)	0 (0)	0 (0)
Private Only	1980	0 (0)	0 (0)	0 (0)	0 (0)
	1990	0 (0)	0 (0)	0 (0)	
	2000	0 (0)	0 (0)	0 (0)	0 (0)
	2010	0 (0)	0 (0)	0 (0)	0 (0)
	2020	2,672 (1,081)	4,626 (1,872)	12,883 (5,214	0 (0)
Total - All Ownerships	all	56,928 (23,061)	66,770 (27,186)	64,706 (26,186)	8,057 (3,261)

TABLE H-3
Federal and Forest Lands
Effects of Plans on National Economic Development Account
Rio Grande Basin, Colorado

Reforestation (Planting) - Acres Per Decade (Hectares)

Ownership	Decade Midpoint	FW	NED	ALT	EQ
Forest Service	1980	36,690 (14,848)	30,000 (12,141)	2,644 (1,070)	3,681 (1,490)
	1990	33,570 (13,586)	30,000 (12,141)	0 (0)	0 (0)
	2000	0 (0)	33,631 (13,630)	28,579 (11,566)	0 (0)
	2010	0 (0)	30,000 (12,141)	27,000 (10,927)	0 (0)
	2020	0 0)	18,464 (7,472)	29,561 (11,913)	0 (0)
Bureau of Land Management	1980	724 (293)	724 (293)	724 (293)	190 (77)
	1990	0 (0)	0 (0)	0 (0)	727 (294)
	2000	0 (0)	0 (0)	0 (0)	0 (0)
	2010	0 (0)	0 (0)	0 (0)	0 (0)
	2020	0 (0)	0 (0)	(0)	0 (0)
State & Private Mixed	1980	0 (0)	351 (142)	45 (18)	900 (364)
	1990	0 (0)	0 (0)	0 (0)	0 (0)
	2000	0 (0)	0 (0)	0 (0)	0 (0)
	2010	0 (0)	439 (177)	0 (0)	0 (0)
	2020	0 (0)	0 (0)	0 (0)	0 (0)
Private Only	1980	0 (0)	0 (0)	0 (0)	0 (0)
	1990	0 (0)	0 (0)	0 (0)	0 (0)
	2000	0 (0)	0 (0)	0 (0)	0 (0)
	2010	0 (0)	0 (0)	0 (0)	0 (0)
	2020	0 (0)	0 (0)	0 (0)	0 (0)
Total	All	70,984 (28,728)	143,659 (58,138)	88,553 (35,837)	5,498 (2,225)

TABLE H-4

Federal and Forest Lands

Effects of Plans on National Economic Development Account

Rio Grande Basin Colorado

Ownership	Decade Midpoint	FW	NED	ALT	EQ
Timber Harvest - Total for 24 Decades - Million Board Feet Log Scale					
Forest Service	All	18,380	20,140	16,991	7,314
Bureau of Land Management		110	110	110	69
State & Private Mixed		485	701	480	266
Private		1,711	3,394	3,013	2,644
Total - All Ownerships		20,686	24,345	20,594	10,293
Annual Lumber Production - Million Board Feet Lumber Tally					
Current Sawmill Efficiency	1980	44.8	75.4	61.7	44.5
	1990	61.0	79.7	72.5	48.9
	2000	72.8	89.7	76.4	51.9
	2010	80.1	89.7	79.4	51.9
	2020	102.2	98.9	82.3	51.9
Improved Sawmill Efficiency	1980	51.2	86.2	70.6	50.9
	1990	69.7	91.1	82.8	55.9
	2000	83.2	102.5	87.4	59.3
	2010	91.6	102.5	90.7	59.3
	2020	116.3	113.1	94.1	59.3
Optimal Sawmill Efficiency	1980	56.4	94.9	77.7	56.1
	1990	76.8	100.3	91.2	61.6
	2000	91.6	112.9	96.2	65.3
	2010	100.8	112.9	99.9	65.3
	2020	128.6	124.5	103.6	65.3

Table H-5

Comparison of Forest Management Inputs Under Two Alternatives of Processing Efficiency

Rio Grande Basin, Colorado

	Thinning		Planting		Net NPV difference
	Acres (Hectares)	NPV	Acres (Hectares)	NPV	
Current Sawing/Utilization Practices			143,659 (58,139)	-7,275,841	
Precommercial	62,144 (25,150)	-3,248,288			
Commercial	4,626 (1,872)	+ 55,975			
Total	66,770 (27,022)	-3,192,314	143,659 (58,659)	-7,275,841	-10,468,155
Improved Sawmill/Utilization Practices			19,188 (7,765)	- 312,251	
Precommercial	80 (32)	- 384			
Commercial	15,220 (6,160)	+ 184,162			
Total	15,300 (6,192)	+ 183,778	19,188 (7,765)	- 312,251	- 128,173
Net NPV Difference					-10,339,982

	Forest Type	
	Douglas-fir	Spruce-fir
CURRENT -		
Min. Tree Diameter (d.b.h.)	10.0	8.0
Max. Top Diameter (d.b.h.)	4.0	6.0
IMPROVED -		
Min. Tree Diameter (d.b.h.)	6.0	5.0
Max. Top Diameter (d.b.h.)	Variable	4.0

Three combinations of sawmill efficiency and in-woods utilization were used to do another type of analysis, i.e., satisfying the OBERS E demand for lumber with better sawmill efficiency and utilization and less forest management cost. The three combinations are:

- current sawing/utilization practices are essentially present-day sawmill and in-woods processing techniques.

- improved sawing/utilization practices entail reconditioning present equipment by tightening and rapairing, and using smaller diameter raw material.

- optimal sawing/utilization practices require installation of modern equipment, such as Best-Opening-Face sawmill equipment, and utilizing smaller raw material in the woods. The latter technique is well within the realm of feasibility in the basin. A fourth level of efficiency would be to go to a reconstitution processing plant wherein the wood is chipped or peeled and reformed into desirable wood products; however, this level was deemed economically infeasible for the Rio Grande Basin.

There was insufficient difference in the results between the improved and optimal levels to justify displaying both. The following discussion is limited to the improved level.

OBERS E demand for sawtimber (board feet log scale) multiplied by the current recovery factor (1.47) equals demand for lumber (board feet lumber tally). This quantity divided by the improved lumber recovery factor (8.25) equals demand for sawtimber (cubic feet log scale). Analysis of the forest resource assuming the improved in-woods utilization reveals that significantly less management costs need to be incurred to meet the demand so calculated. Table H-5 compares the acreage to be planted and thinned and the associated net present value (interest rate = 6 1/8%) between the current sawing and utilization level alternative and the improved sawing and utilization level alternative.

The analysis suggests that if the investment required to upgrade the sawmills and log handling equipment plus the present value of additional handling costs of the smaller material is less than the $10 million

present value of the thinning and planting, the sawmill improvement is the better investment. Further analysis should be done to determine the cost of sawmill improvement.

Compromise Environmental Quality Plan - The negative net present value (NPV) of the EQ plan can be attributed mainly to the objective of the plan--maximize total environmental quality without regard to economic impact. If a compromise is allowed to reduce the Esthetic and Development & Use Environmental Quality Indexes by 1 point each in exchange for a slightly greater timber harvest with an associated slight increase in water yield and erosion, the NPV can be positive. This points out rather well that the cost of attaining a small unit of environmental quality increases greatly as it nears its maximum value. The same would hold true in the NED plan; the closer one comes to producing the last board foot of timber that the forests are capable of producing, the higher the cost for that board foot.

Environmental Quality Indexes - The Environmental Quality Indexes shown in Table H-6 encompass a wide variety of variables. Briefly, each environmental quality category is defined and includes such parameters as:

(a) Water Quality - an evaluation of the effect of land management activities on fisheries and recreation objectives per PL-92-500. Variables used in the evaluation indicate degrees of environmental pollution by considering stream biochemical oxygen demand, fecal coliforms, inorganic nitrogen, turbidity and temperature.

(b) Esthetic Quality - directed toward indicating recreational desirability of a landscape situation. Parameters involved in determining this quality are diveristy of vegetation; type and amount of litter; water conditions; geologic surface materials; topographic relief and character; wild and domestic animals; and visual quality.

(c) Wildlife Quality - designed to present an indication of relative overall ecological soundness of a situation for wildlife habitation as a whole. Parameters affecting the evaluation are forage used by browsers and grazers; permanent vegetation; non-game birds; sport fish; threatened and endangered wildlife; amount of sound and noise; and disruption of normal life pattern.

(d) Development and Use Quality - is intended as an indication of the suitability of a situation to provide for human welfare. Factors for evaluating the degree of human welfare being provided in a situation include susceptibility of cultural improvements to property damage; emergency escape opportunities in time of catastrophe; early warning system of impending emergency; conflicts of use, both land and facility; and degree of risk of wildfire.

(e) Total Quality - an overall average value, giving equal weight to each of the four environmental quality category indices above, comprises the total quality index.

From the description of composition of each of the environmental categories, it should be evident that, in a given situation, a "compensatory effect" comes into play. That is to say that while one index value (or even a parameter within the index) may receive a relatively high value, another associated index or parameter may be assigned a low value. For example, what is good for endangered species may have adverse effects on small game (parameter compensation) or what is beneficial for wildlife is not desirable for human welfare (categorical compensation). Realizing these cause/effect relationships, one can better appreciate the rather insensitive nature of an index to small variations.

To further bring the indexes presented in Table H-6 into perspective, the values below represent the maximum attainable in the basin for each category:

Water Quality -----------------	91
Esthetic Quality ---------------	75
Wildlife Quality ---------------	64
Development & Use Quality ------	74
Total Quality -----------------	76

The process involved in the derivation of each index is quite complicated, but as much objectivity is maintained as is currently feasible for this type of evaluation. While a description is too voluminous for this report, procedural details are available at AP&D, SP&F, R-2 River Basin Planning Team, USDA Forest Service, Denver, Colorado.

Derivation and Use of Wilderness Projections

When viewing the projected use of wilderness-type areas for recreation, one must bear in mind the fact that not all people using wilderness-type areas are actually seeking the purist experience. According to research, nearly 20% of the visitors responding to questionnaires were probably seeking an experience that could be provided outside a pure wilderness or that perhaps as high as 40% of the people could be satisfied with a "backcountry" experience. This could be afforded them in many areas not suitable for wilderness under the strict Forest Service interpretation of the law.

Summaries of the two papers are included in the following pages. The percent of responses either "favorably disposed to" or "neutral toward" intensities of use or management activities not in accord with the strict interpretation of the law are averaged for each study. The average of the two studies is 40%.

TABLE H-6

Federal and Forest Lands
Effects of Plans on Environmental Quality Account
Rio Grande Basin, Colorado

OBERS E' SCENARIO		ENVIRONMENTAL QUALITY ACCOUNT			
Wilderness & Backcountry Recreation - Visitor Days Per Year					
	Decade Midpoint	FW	NED	ALT	EQ
Wilderness Forest Service Only	2020	42,418	16,500	37,500	44,900
Backcountry	2020	0	11,000	26,134	30,000
Wilderness & Backcountry Recreation - Acres (Hectares)					
Wilderness Forest Service Only	2020	379,800	209,330	316,260	453,902
		(153,705)	(89,716)	(127,990)	(183,694)
Backcountry Forest Service Only	2020	0	53,774	143,964	159,627
		(0)	(21,762)	(58,262)	(64,601)
Developed Recreation - Visitor Days Per Year					
Forest Service	1980	591,440	591,440	591,440	591,440
	2020	640,970	648,180	648,180	648,180
Bureau of Land Management	1980	0	0	0	0
	2020	0	0	0	0
State & Private Mixed	1980	10,008	10,008	10,008	10,008
	2020	10,008	10,008	10,008	10,008
Private Only	1980	874,800	874,800	874,800	874,800
	2020	874,800	874,800	874,800	874,800
National Park Service	1980	79,154	79,154	79,154	79,154
	2020	79,154	79,154	79,154	79,154
Total - All Ownership	1980	1,555,402	1,555,402	1,555,402	1,555,402
	2020	1,604,932	1,612,142	1,612,142	1,612,142

It is recognized that fewer than 40% of the people will share the non-purist view in total. However, this research also indicates that people are polarized, i.e., the purists are fairly consistent in their attitudes. The reverse is assumed, i.e., the set of people who favor pit toilets probably are included in the set who favor hitching racks and meeting people.

For this study 60% of the use projected is assumed to be a use which can be satisfied only in a wilderness area. Forty percent is assumed to be a use which can be satisfied in a less pristine area managed to accommodate more people per acre per year than is appropriate in wilderness. The process utilized to arrive at wilderness and backcountry use disaggregation is included in this Appendix.

Disaggregation of the national projection of wilderness use to the Rio Grande Basin, Colorado was done per the following procedure:

Present and potential wilderness in basin, (Table H-4) 613,529 acres (248,295 ha), divided by Present and potential wilderness in 48 contiguous states, (Table H-3) 76,296,600 acres (30,877,230 ha), results in 0.8% of wilderness potential located in the basin.

Ward's estimate of National Wilderness and backcountry use in 2020 for OBERS E' conditions is 166 million visitor days. Taking 0.8% of this figure results in 1,328,000 visitor days demand allocated to the Rio Grande Basin. Using the wilderness/backcountry 60/50 proportion, the basin's visitors days factor out to 796,800 and 531,200 respectively. Since the OBERS 'C' national demand is 220 million, the respective wilderness and backcountry values for the basin's total share of 1,760,000 visitor days are 1,056,000 and 704,000.

The ORRRC procedure used to project wilderness use on national forest wilderness units was to correlate past use with per capita disposable income. As disposable income increased, the rate of use, as measured by man-days per 1,000 population, increased. The projections of future disposable income (not igven in the report) result in projected rates of use which multiplied by projected population arrives at projected wilderness use.

The ORRRC projection slightly underestimated actual use in 1959 and overestimated use in 1976. Correcting the use rate, per the 1976 deviation, results in a projected use of 24,366,000 visitor days based on the OBERS E population projection.

The average annual increase in use from 1947 to 1976 was approximately 10%. If the projection above holds true, the increase from 1947-2020 will be approximately 5% and the increase from 1976-2020 will be approximately 2.5%.

VISITOR PERCEPTION OF WILDERNESS RECREATION CARRYING CAPACITY[3]
(1973 INT 142 George Stankey)

Percent of respondents favorably disposed to or neutral toward the following:

Meeting other parties on trail	51%
Meeting other parties around fire	55%
Most enjoyable when you meet people in the area	44%
Max. enjoyment = seeing one group per day	25%
Don't mind seeing large parties	33%
Camping near several other parties	17%
Prefer to camp near others	14%
Prefer more high quality trails	34%
Signs indicating camping places	36%
More campsites	25%
Hitching racks	25%
Corrals	13%
Pit toilets	38%
Bridges on large streams	65%
	$\bar{x}$ 33.2

WILDERNESS USERS IN THE PNW, THEIR CHARACTERISTICS
VALUES AND MANAGEMENT PREFERENCES[1]
(1968 PNW-61 John Hendee, etal.)

Percent of respondents favorably disposed to or neutral toward following:

Montorized trail bikes	20%
High quality trail	30%
Toilets	50%
Log or pole tables	40%
Corrals	50%
Hitching racks	60%
Three sided shelter	60%
Concrete fireplaces	0
Drift fences	30%
Control of fire or I. & D.	90%
Artificial restoration	90%
Timber management	50%
$\bar{x}$	47.5

Table H-7

TOTAL POTENTIAL WILDERNESS OR BACKCOUNTRY AREA IN THE UNITED STATES
(48 Contiguous U.S.)
Rio Grande Basin, Colorado

Administrator:	Acres	Hectares
Area of existing wilderness, plus areas studied and submitted to Congress - includes Forest Service, U.S. Fish & Wildlife Service and National Park Service:[4]	39,2000,000	15,864,240
Total roadless area less Alaska & Puerto Rico equals contiguous 48 states:[5] 56,000,000 - 20,706,400 = 22,663,200 - 8,379,880	35, 293,600	14,283,320
Area of:		
BLM primitive areas:	164,000	66,370
BLM potential primitive areas:[6]	1,639,000	663,300
Total - 48 States	76,296,600	30,877,230

Table H-8
ROADLESS AND WILDERNESS AREAS

Rio Grande Basin, Colorado

Name	Map No.	Acres	Hectares
Roadless Areas:*			
Sangre de Cristo	RF	71,107	28,777
Zapata	RI	30,080	12,173
Wheeler-Wason	RA	62,691	25,371
Chama-S. San Juan	RE	116,844	47,287
Pole Mountain	RG	52,825	21,378
Snow Mesa-Bristol Head	RH-1	12,160	4,921
Snow Mesa-Bristol Head	RH	31,305	12,669
Bennett Peak	RJ	27,600	11,170
Willow Peak	RK	21,150	8,560
Fox Mountain	RL	6,810	2,756
Lake Fork-Saguache Creek	RB	5,338	2,160
Saguache Creek	RN	13,905	5,621
Sheep Creek	RO	12,105	4,899
Subtotal		463,920	187,748
Wilderness Areas:			
La Garita		22,458	9,089
Weminuche		127,151	51,458
Subtotal		149,609	60,547
Total All Rio Grande Basin Areas		613,529	248,295

*All or portions of the areas: Upper Rio Grande (RC); Deep Creek-Decker Creek (RD); and Quartzite (RM) were included in the Weminuche Wilderness enlargement; those portions not included are assumed as returned to Multiple-Use Management.

The above projections were for activity on national forest land only. The anticipated rate of growth applied to the 11 million visitor days of total wilderness use in 1974 (RPA Assessment, p. 10) projects to 32,670,000 in 2020.

The basin's share of this demand is 0.8% or 261,360 visitor days. Sixty percent, or 156,816 visitor days, is demand for wilderness and 40%, or 104,544 visitor days, is demand for backcountry.

Projection of Recent-Use Data

The growth rate of reported use on National Forest Wilderness and Primitive areas from 1966 to 1976 is approximately 3-5/8%. This is a conservative estimate of use because a substantial amount of unmeasured use is occurring on roadless areas. These roadless areas were unidentified and not controversial in 1966. The use on these areas has increased from an insignificant level in 1966 to a significant amount in 1976. Since it is unmeasured, it cannot be accounted for. Applying this 3-5.8% rate of increase to the estimated 11 million visitor days of total wilderness use in 1974 projects 54,900,000 visitor days in 2020 nationally.

Unpublished projections of wilderness use (mentioned in the 1975 RPA Assessment, p. 102) show a rate of growth from 1976 to 2000 of 3-7/8%. Applying this rate of growth to the 11 million visitor days of total wilderness use in 1974 projects to 63,227,000 visitor days in 2020. The latter two projections result in values between the lowest (ORRRC) and the highest (Ward) and, therefore, are carried no further (See Table H-9).

TABLE H-9

PROJECTED ESTIMATES TO 2020 OF WILDERNESS USE FOR THE UNITED STATES AND THE RIO GRANDE BASIN, COLORADO*

(1000 Visitor Days)**
(based on OBERS 'E' population projections)

Data Source	National Total Use	Rio Grande Basin Total Share	Rio Grande Basin Wilderness	Rio Grande Basin Backcountr
Ward[8]	166,000	1,328	796.8	531.2
RPA[6] 3 5/8%	54,900			
RPA[6] 3 7/8%	63,227			
ORRRC[2]	32,670	261	104.5	156.8

* One must bear in mind that estimates of Wilderness Use, whether actual or projected, are at best, gross approximations, but are based on the most current data available.

** Not all numbers may add exactly due to rounding.

References to Wilderness Projections and Disaggregation

1 Hendee, John A., W. R. Catton, Jr., L. D. Marlow and C. F. Brockman. 1968. Wilderness Users in the Pacific Northwest Their Characteristics, Values, and Management Preferences. USDA Forest Service Res. Pap. PNW-61. Pacific Northwest For. & Range Exper. Sta., Portland, Oregon.

2 Outdoor Recreation Resources Review Commission. 1962. Report No. 3, Wilderness Use Projection. Washington, D.C.

3 Stankey, George H. 1973. Visitor Perception of Wilderness Recreation Carrying Capacity. USDA Forest Service Res. Pap. INT-142. Intermountain For. & Range Exper. Sta., Ogden, Utah.

4 USDA Forest Service. 1976. RPA, A Recommended Renewable Resource Program. Final Environmental Statement and Renewable Resource Program-1977-2020. Washington, D.C. p. 73

5 USDA Forest Service. 1973. Roadless and undeveloped areas (Final Environmental Statement). Washington, D.C. p. 15

6 USDA Forest Service. 1975. RPA, The Nation's Renewable Resources-an assessment, 1975. Washington, D.C. p. 105. (See also RPA Assessment Draft, p. 128.)

7 USDA Forest Service, 1973. National Forest Wilderness, Primitive and Inventoried Roadless Areas in Colorado. (Map). Washington, D.C.

8 Ward, Frank A. 1976. Estimates of Wilderness Consumption for the Year 2020. Research paper submitted to USDA Forest Service, River Basin Programs, Denver, Colorado.

OBERS Forestry Projections
Disaggregation Process for Colorado

Calculation of Colorado's share of National Growth capability.

Reference: USDA Forest Service. 1973. The Outlook for Timber in the United States. FRR-20.

Capability: Measure in cubic feet/acre/year of fully-stock natural stands (Outlook, p. 14). For calculation purposes, capability values used for each class in Outlook, Table 5, p. 237-39:

Class (Cubic feet)	Value Used (Cubic feet)
165 or more	165
120-165	142
85-120	102
50-85	68
less than 50	35

These values were applied to the acres assigned to each class in Outlook, Table 5, p. 238, for both Colorado and the United States, resulting in a capability factor of:

$$\frac{\text{Colorado} \quad 396{,}623{,}000\ ft^3/yr}{\text{United States} \quad 37{,}379{,}721{,}000\ ft^3/yr} = 0.0106$$

Commercial Forest Land (CFL):

Colorado = 11,583,000 acres (4,687,640 ha) - (Outlook, Table 5, p. 238)
Rio Grande Basin = 1,100,000 acres (445,170 ha) - (See below)

Commercial Forest Land in Rio Grande
Basin, Colorado

Owner/Administrator	Commercial Forest Acres	Hectares	Percent
U.S. Forest Service	879,294[1/]	355,850	79
Bureau of Land Mgmt.	20,009[2/]	8,098	2
Private	164,000	66,370	15
State & Private Mixed	47,732	19,317	4
TOTAL	1,111,035	449,635	100

Source: Rio Grande Type IV Study.

1/ Includes 73,097 acres (29,582 ha) of low site nonstocked areas not planned for reforestation. This is not included in data in Chapter 5 as part of resource base. Also includes 5,455 acres (2,208 ha) of potential recreation sites, which is included in Chapter 5.

2/ Includes 40 acres (16 ha) of potential recreation site.

Rio Grande Sawtimber Demand Disaggregation OBERS 'E' Level

	Decade Midpoint				
	1980	1990	2000	2010	2020
U.S. Demand 1/ (Roundwood M ft^3)	15,600,000		21,900,000		29,000,000
Colorado Share = .0106 x U.S. 2/ (Roundwood M ft^3)	165,360		232,140		307,400
Colorado Share ft^3 ÷ Colorado CFL 2/ (ft^3/ac)	14.28		20.04		26.54
Per Acre Share x Basin Acres (Roundwood M ft^3)	15,708	(18,876)[a]	22,044	(25,619)[a]	29,194
ft^3 x % ST 3/ (Sawtimber M ft^3)	12,252	(14,503)[a]	16,753	(16,989)[a]	17,224
ft^3 x 4.9 ≈ ST MBF Scrib. 4/	60,000	76,000	82,000	83,000	84,000
Residual (pulp) (Roundwood M ft^3)	3,500	4,800	5,300	8,700	12,000

1/ OBERS 'E' Vol. 1, Table 8, p. 61 "Roundwood Production ft^3"

2/ See page A-1

3/ OBERS 'E' Vol. 1, Table 19, p. 107, Colorado sawtimber roundwood as percent total Roundwood. 1980 = .78; 2000 = .76; 2020 = .59

4/ Rio Grande Potential Yield Statement: 4.9 bd.ft. Scribner = /ft^3

a/ numbers in ( ) are interpolated

RIO GRANDE SAWTIMBER DEMAND DISAGGREGATION OBERS 'C' LEVEL

	Decade Midpoint				
	1980	1990	2000	2010	2020
U.S. Demand[1] (Roundwood M ft.^{3})	19,080,000		29,120,000		34,600,000
Colorado Share = .0106 x U.S. [2] (Roundwood M ft.^{3})	202,248		308,672		366,760
Colorado Share ft.^{3} ÷ Colorado CFL[2] (ft.^{3}/acre)	17.46		26.65		31.66
Per Acre Share x Basin Acres (Roundwood M ft.^{3})	19,206		29,315		34,826
ft.^{3} x % ST [3]= (Sawtimber M ft.^{3})	15,173		23,159		24,378
ft.^{3} x 4.9 ≈ ST MBF Scrib.[4]	74,000	104,000	113,000	117,000	119,000
Residual (pulp) (Roundwood M ft.^{3})	4,000	5,600	6,200	8,700	10,400

[1] OBERS 'C' Vol. 1, Table 8, p.63 "Roundwood Production ft.^{3}"

[2] See Page A-1

[3] OBERS 'C', Vol. 1, Table 19, p. 108, Sawtimber roundwood as percent of total roundwood: 1980 = .79; 2000 = .79; 2020 = .70

[4] Rio Grande Potential Yield Statement: 4.9 bd.ft. Scribner = 1 ft.^{3}

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APPENDIX I

EXISTING PROGRAMS

APPENDIX I

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EXISTING PROGRAMS — PAGE

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EXISTING PROGRAMS

1. Department of Agriculture

a. Soil Conservation Service

The Soil Conservation Service is the technical soil and water conservation agency of the U. S. Department of Agriculture (USDA) responsible for developing and carrying out a national program of conservation for land and water resources. It administers USDA activities involving technical and financial assistance for planning and executing programs to protect and improve water and related land resources in small watersheds, cooperating closely with federal and state agencies that deal with loans, cost sharing, fish and wildlife, recreation, and other matters related to land and water use.

The Soil Conservation Service under the Soil Conservation Act (Public Law-46, 74 Congress 1935) carries on a broad program of direct assistance to farmers and ranchers through soil conservation districts, as well as aiding other agencies. Related activities include farm and ranch planning and assistance in initiation of conservation practices, soil surveys and investigations, plant material improvements for conservation work, snow surveys and water supply forecasts, technical assistance to other USDA activities, and aid to other agencies responsible for administering conservation work on private lands. Five soil conservation districts plan and carry out a program of soil and water conservation over most of the land (95 percent) in the basin.

The Great Plains Conservation Program is a program administered by the Soil Conservation Service in which the landowner or cooperator enters into a 3 to 10 year contract with the USDA. Technical and cost share assistance are available on land treatment and engineering practices that may be applied to produce a complete conservation program to the land involved. This program is available in Alamosa, Conejos, Costilla, Rio Grande, and Saguache counties of the Rio Grande Basin.

Public Law-566, 83rd Congress 1954, provides federal assistance to sponsoring organizations for planning and installing watershed projects. Watershed protection and flood prevention work is one of the programs carried on by the USDA through the administrative leadership of the Soil Conservation Service. The SCS assists sponsoring agencies, such as soil conservation districts, and state or local governments in planning and executing the upstream watershed protection measures. The

Forest Service, Farmers Home Administration, Bureau of Land Management and other federal, state, and local agencies assist in developing these projects. Respective land administering agencies are responsible for planning and applying treatment on federal lands within the watershed project.

A Resource Conservation and Development program is a locally initiated and sponsored activity to expand the economic opportunities for the people of an area by developing and carrying out a plan of action for the orderly conservation, improvement, development and wise use to their natural resources.

All interests in an area--rural, suburban, and urban--work together to develop natural and related resources. Local people organize and apply through one or more legal sponsors such as a conservation district, a county governing body, or a town for assistance from the USDA which by authority of the Food and Agriculture Act of 1962 gives technical and financial help. An RC&D project has been approved for planning in the San Luis Valley which includes all of Alamosa, Conejos, Costilla, Rio Grande, and Saguache counties in addition to portions of Archuleta, Hinsdale, and Mineral Counties. The project boundaries approximate the Rio Grande Basin drainage area.

The USDA carries out flood hazard analyses under authority of Section 6, Public Law 83-566, in accordance with Recommendation 9(c) of House Document No. 465, 89th Congress. Reports of flood hazards and other flood plain data are intended for use by states, municipalities, planning commissions, or other units of governments responsible for land use planning and regulation to reduce potential flood losses caused by development on flood plains along streams.

The Soil Conservation Service cooperates with the Department of Housing and Urban Development in the National Flood Insurance Program by furnishing information on frequency of flooding and extent of flood damages. This program makes flood insurance available at relatively low rates due to federal cost sharing, but requires that appropriate flood plain regulations be adopted to participate. The SCS provides technical assistance to the community in meeting the requirements of the program.

Snow surveys have been made in the Rio Grande Basin since 1935. This cooperative program provides a means of aiding water supply forecasting from melting snow. The snowpack yields as much as 80% of the total water for the basin, with underground storage fluctuating with the snowpack. Appendix E provides a detailed discussion of the water supply forecasting program.

Public Law 95-87, Section 406, provides funds for the SCS-Rural Abandoned Mine Program (RAMP). This a voluntary program, offering technical and cost share assistance, which applies only to reclamation of abandoned, coal-mined lands, but not all abandoned coal-mined land will be reclaimed under this program. The objectives of the program are to protect people and the environment from the adverse effects of past coal mining practices and to promote the development of the soil and water resources of unreclaimed lands.

Section 208 of Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972 provides Federal and State programs to prevent and reduce to exceptional levels nonpoint pollution sources. The Soil Conservation Service and local Soil Conservation Districts, together with Section 208 planning agencies, may provide assistance for solutions to the nonpoint pollution problems. These solutions will center on "Best Management Practices." These may include some of the conservation practices that have been used for many years, however, new techniques will need to be developed.

The Resources Conservation Act, Public Law 95-192, 95th Congress 1977, administered by the Soil Conservation Service is a companion measure to the Resources Planning Act of 1974, administered by the Forest Service. The two laws direct USDA to make a total assessment or appraisal of America's basic natural resources and to help protect and improve them. Under this law the SCS will appraise the nation's soil, water, and related resources; develop a comprehensive 5-year program or strategy to guide conservation efforts; and evaluate the effectiveness of ongoing conservation programs. SCS will carry out the work in cooperation with appropriate citizen groups, Soil Conservation Districts, and other Federal, State, and local agencies. The appraisal and program will be completed by the end of 1979 and updated every 5 years.

b. Agricultural Stabilization and Conservation Service

The Agricultural and Stabilization and Conservation Service (ASCS) administers programs that provide cost-sharing to farmers and ranchers for conservation practices of public benefit. Its Agricultural Conservation Program (ACP) provides enduring conservation benefits on land where conservation practices are applied and shares costs with farmers and ranchers for conducting conservation practices. ACP cost-shared practices are coordinated through ASCS county committees and include: establishing permanent protective cover on range and farm land; improving and protecting established cover; systems to conserve and dispose of water; protecting soil

from wind and water erosion; establishing wildlife habitat; and special conservation needs as determined locally. The Soil Conservation Service and Forest Service are responsible for technical phases of many ACP practices.

c. Forest Service

As a federal land management agency, the U. S. Forest Service is responsible for planning and implementing water, timber, range, recreation and wildlife resource programs on the 1.8 million acres of the Rio Grande National Forest. In addition to these land management responsibilities, the Forest Service also administers cooperative forestry programs and performs forestry research.

(1) National Forest Management

Watershed program objectives of the national forest are directed toward preserving and improving soil productivity; optimizing water quality, quantity and runoff; avoiding pollution; rehabilitating degraded watersheds; and establishing rights for the use of water for national forest purposes.

Meeting its share of the nation's timber demand on a nondeclining, evenflow basis is a main feature of the Rio Grande National Forest Timber Program. Accomplishment of this objective is by: marketing allowable harvest; reforesting poorly and nonstocked forest lands; implementing proper silvicultural and fuel management techniques; constructing and maintaining adequate transportation systems; and conducting timber stand improvements.

Forage on national forest lands for cattle, sheep and recreation livestock is maintained and improved through the range program which adjusts livestock numbers and grazing seasons relative to range capacity by conducting inventories; constructing fences; developing water; renovating deteriorated range; and controlling livestock trespass.

Adequate developed recreation facilities and dispersed recreation areas are provided through the recreation program by: establishing and maintaining appropriate facilities to serve present and future needs; preventing pollution, fires, and resource damage; ensuring safety and sanitary conditions for the user; recommending

qualified roadless areas for inclusion in the National Wilderness Preservation System under PL 88-577, in addition to the Weminuche and La Garita Wilderness Areas presently established to provide areas of solitude.

Wildlife itself on national forest lands is a state resource; consequently, the federal programs are aimed mainly at providing productive fish and game habitat by protecting key food and nesting areas; creating forest openings; planting for food and cover; and controlling distribution.

(2) Federal-State Cooperative Forestry

Cooperative Forestry programs are generally designed to protect forest resources and promote better forestry practices on state and private forest lands, the private ownerships being serviced through appropriate state forestry agencies.

The Weeks Law of 1911 and Clarke-McNary Act of 1924 authorized the organization and maintenance of fire protection systems and cooperative fire control on all forests and critical watersheds in state and private ownership. The state forestry organization provides program manpower, supervision, and administration while the USDA Forest Service role is to provide services, training and some funding. The Granger-Thye Act of 1950 gave further impetus to these programs by providing funds for the construction of buildings, fire lookout towers and other structures on non-federal lands.

Improved forest land management, harvesting, marketing and processing through technical assistance to private forest landowners, operators and processors of primary forest products was the aim of the Cooperative Forest Management Act of 1950. This Act authorized Forest Service cooperation with state foresters and provided funds for developing, managing, and utilizing forest resources so as to contribute to economic development and environmental quality. The Forestry Incentives Program, Agriculture and Consumer Protection Act of 1973, also was intended to encourage non-industrial private forest owners to practice intensive forest management and protect forest resources.

Cooperative tree planting programs allow private landowners to obtain tree seedlings through state forestry organizations for windbreaks, shelterbelts and reforestation, as well as technical and federal financial assistance. Forest Service cooperation with states for

growing and distributing forest seeds and planting stock is authorized by Section IV of the Clarke-McNary Act. Assistance for restocking commercial forest lands is authorized by the Agricultural Act of 1956 which provides for cost-sharing of site preparation, tree planting and seedlings on state and private lands.

The Forest Pest Control Act of 1947 allows federal-state cost sharing for survey, detection, evaluation and control of forest pests on nonfederal lands by cooperating with the state forester or other state officials.

(3) Forestry Research

The Rocky Mountain and Intermountain Forest and Range Experiment Stations undertake investigative studies relating to all the forest and range resource programs, particularly regarding water, forage and timber yields, recreation and wildlife.

d. Farmers Home Administration

The Farmers Home Administration (FmHA) was established to help rural people and small communities develop their resources and solve their problems through a variety of loan programs available to qualified individuals, associations, cooperatives or public bodies. The Soil Conservation Service cooperates with FmHA by reviewing technical phases of loan applications that deal with soils information, engineering design, and layout and related soil or water problems.

e. Rural Electrification Administration

The Rural Electrification Administration (REA) administers two loan programs for rural electrification systems and power generating facilities, and extension and improvement service loans. Loans for rural electrification are made to cooperatives, public utility districts, municipalities and power companies to finance generating, transmission and distribution systems for providing electricity to rural areas without central station electric service.

f. Science and Education Administration - Extension

The Extension Service is the educational branch of the USDA. Federal, state, and county governments share in financing, planning, and carrying out information and education programs.

g. Economic Statistics and Cooperatives Service

The Economic Statistics and Cooperative Service studies the short and long-term agricultural demands for land and water resources, and evaluates the effect of alternative potentials for development of such resources on the agricultural and related sectors of the economy. The ESCS and the Office of Business Economics in the Department of Commerce cooperate in a program of national and regional economic projections, and in the maintenance of an automated system to store, retrieve, and analyze economic data. These data are used to support the planning endeavors of the Water Resources Council and its member agencies.

h. Science and Education Administration - Federal Research

The Science and Education Administration - Federal Research conducts research aimed at improving and maintaining production in all phases of agriculture and protecting the invaluable soil and water resources. The research program within the field of soil, water, and air sciences is oriented primarily to the needs of farmers and conservationists for scientific determination of the feasibility and effectiveness of soil and water conservation practices. Research is continually pursued on both the physical requirements and the physical effects of soil and water conservation. Examples of the many studies underway are water management, including soil-water storage, crop use and improving water quality through efficient use of chemicals; sediment yield, delivery rates, and nutrient losses; conservation cropping, including the chemical and microbiological aspects and residue management; management and utilization of agricultural wastes, including animal wastes; and the hydraulic characteristics of overland runoff and of surface methods of irrigation.

2. Department of the Army

a. U. S. Army Corps of Engineers

Since flood damages are minor there has not been any need for large scale flood control projects. The city of Monte Vista asked the Corps of Engineers to prepare a "Flood Plain Information" report to define the flood situation along the Rio Grande in the vicinity of Monte Vista, Colorado in 1969. This report is completed.

The Corps of Engineers is responsible for permits authorizing structures and work in or affecting navigable waters of the United States, the discharge of dredged or fill material into navigable waters, and the transporation of dredged material for the purpose of dumping it into ocean waters.

3. Department of Commerce

a. National Oceanic and Atmospheric Administration

The NOAA was created to provide an organization which would employ a unified approach to the problems of the oceans, of the atmosphere, and of the solid earth. NOAA gathers, processes, and issues information on:

(1) weather, river and climatic conditions,
(2) coastal tides and currents,
(3) movement of ocean currents,
(4) structure and shape of ocean basins,
(5) seismic activity,
(6) precise size and shape of the earth,
(7) living resources of the global sea,
(8) economic aspects of fisheries' operations,
(9) ecological relationships between game fish and other marine and estuarine organisms,
(10) marine mining and related technology, and
(11) conditions in the upper atmosphere and space.

NOAA maintains warning systems against hurricanes, tornadoes, floods, seismic sea waves, and other environmental hazards. NOAA enhances the government's ability to provide better environmental information to vital segments of the nation's economy such as industry, communications, transportation and agriculture.

4. Environmental Protection Agency

The Environmental Protection Agency has been assigned responsibilities to protect and enhance man's environment. Land, air, and water resource projects are reviewed to assure that adequate consideration and evaluation has been given to the total effects of the project. The Water Quality Office develops basin-wide water pollution control programs, reviews waste treatment control of all federal installations, including water resource projects, and also reviews the applications for licenses submitted to the Department of Energy. It is responsible for assuring that water quality standards established on interstate streams are not violated.

5. Department of Housing and Urban Development

a. Federal Insurance Administration

The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973, were designed to share the risk of flood losses through a program of subsidized flood insurance in communities with flood plain management programs to guide new development.

b. Community Planning and Development

The Community Development Program provides assistance in the development of viable urban communities. This program, includes but is not limited to, providing decent housing, a suitable living environment and expanding economic opportunities principally for persons of low and moderate income.

6. Department of Interior

a. Bureau of Land Management

The Bureau of Land Management is responsible for managing some 516,000 acres (208,825 ha) of public lands in the basin, consisting of commercial and noncommercial forest, big game habitat and domestic livestock range lands. Its overall management objective centers around the principle that these lands will be devoted to the best combination of utilization by administering the lands for recreation, wildlife, minerals, wood, water, forage, open space and community growth.

To meet this objective requires carrying out a coordinated soil and water conservation program for watershed protection; improving range conditions through better management and improvements as fencing, water development, seeding, etc; granting grazing licenses, permits and leases compatible with range capacity; managing forest resources on a sustained yield basis; maintaining forest productivity through timber stand improvement, insect and disease control, and harvesting; administering a comprehensive mineral leasing program on the public lands and other ownerships with federally-owned mineral rights; cooperating with other federal, state and local agencies involving the management and development of recreation and wildlife resources.

b. National Park Service

The Sand Dunes National Monument comprises nearly 39,000 acres (15,783 ha). As the managing agency, the Park Service is charged with protecting and maintaining the monument for the benefit and enjoyment of the public.

c. Fish & Wildlife Service

The Fish and Wildlife Service has two wildlife refuges in the basin located near Monte Vista and Alamosa. The primary purpose of these refuges, totaling some 23,000 acres (9,308 ha), is to create suitable habitat for migratory birds, waterfowl and upland game.

d. Bureau of Reclamation

The Bureau of Reclamation has been very active in the basin and presently has the "Closed Basin Division San Luis Valley Project Colorado" authorized for construction. This project is designed to facilitate the optimum salvage and delivery to the Rio Grande of waters now being nonbeneficially consumed within the Closed Basin, insure that such water salvage does not adversely affect existing irrigation developments, preserve and enhance existing wildlife habitat, and provide desirable fishing and recreational benefits. The plan provides for installation of a system of wells, pumping plants, laterals, and main canals to salvage ground and surface waters within the adopted salvage areas. Selective operation of the wells is contemplated, in order to achieve the maximum practicable discharge from the main conveyance channel into the Rio Grande of water which will enable Colorado to fulfill its compact commitments and meet quality of water requirements of the Rio Grande Compact. The plan provides for development of the Mishak Lakes National Wildlife Refuge and for authorization of and delivery of salvaged water to the Alamosa National Wildlife Refuge in accordance with the recommendations of the Fish and Wildlife Service. The plan also provides minimum basic recreational facilities at San Luis Lake in accordance with the recommendations of the National Park Service.

e. Geological Survey

The Geological Survey is a technical and scientific organization which is deeply involved in defining the nation's natural resources. It collects, interprets, and disseminates information on the mineral and water resources of the nation and physical features of the country, and prepares the standard geologic and topographic map series of the country. The Survey has the responsibility for obtaining and furnishing much of the physical data needed for planning, design and operation of water resource projects.

f. Heritage Conservation and Recreation Service

The Land and Water Conservation Fund Program, administered by Heritage Conservation and Recreation Service, remains the major source of federal financial assistance for outdoor recreation projects. Funds are administered through the State Liaison Office in the Colorado Division of Parks and Outdoor Recreation for planning, acquisition, and development of public outdoor recreation areas and facilities.

7. State, Local and Other

a. Colorado Water Conservation Board

The local people, through the Rio Grande Water Conservation District and the Conejos Water Conservancy District, are accomplishing a water-saving program, whereby the Colorado Water Conservation Board has been providing technical advice and financial assistance.

The Conejos River is one of twelve Colorado rivers authorized for study as potential additions to the National Wild and Scenic Rivers System under Public Law 93-621. The state of Colorado requested that studies be conducted jointly and designated the Colorado Water Conservation Board as lead agency for state input.

b. Colorado Division of Water Resources

The Colorado Division of Water Resources (State Engineer's Office) is involved in three areas of water resource utilization and management in the Rio Grande Basin. These include water administration; investigation of aquifer condition to determine interference with existing surface rights; and geothermal investigation to determine potential interference with existing water rights by geothermal development.

c. Colorado Division of Water Quality Control

The Division's programs involve water quality monitoring and planning, and sampling and analyzing waste water treatment plant effluents. Phase II water quality management planning (208 planning) has been initiated for the basin, this level of planning building upon the Phase I (303e) plan and concentrating on best management practices for agricultural and mining activities for the protection of water quality.

d. State Board of Land Commissioners

The State Board of Land Commissioners manages about 208,500 acres (84,380 ha) of state lands in the Rio Grande Basin, which include grazing leases, commercial leases, timber sales and management, oil and gas leases, and leases for other minerals.

e. Colorado Department of Local Affairs

Within the Department of Local Affairs the Division of Planning and the Division of Commerce and Development are involved in resource activities. The latter division is primarily involved in rural job development and economic assistance. This

includes close liaison with communities in efforts to persuade established companies to expand their operations in the basin. The Community Development Section conducts economic studies in the basin, as well as throughout the state. The federally funded technical assistance and supplemental grants, administered by the Four Corners Regional Commission, are handled through the Division of Commerce and Development. A cooperative study to determine the impacts of weather modification (cloud seeding) on the snowpack is presently underway through a technical assistance grant.

The Division of Planning is involved in activities as: preparing population projections which support and give direction to water resource planning and development; providing funds to counties to conduct a program of identification and designation of specified types of natural hazard areas; administering state programs under Section 701 of the Housing and Urban Development Act of 1965, which provides for grants to assist state and local governments and other agencies to solve planning problems.

f. Colorado Division of Wildlife

Programs of the Colorado Division of Wildlife include land acquisition, development and management related to recreation, hunting and fishing activities (figure IV-5). Some of the more prominent acquisitions include Hot Creek, Meyers Creek, and La Jara Creek. Development of areas involve Beaver Creek Reservoir with the installation of outlet tube, and La Jara Wildlife Area by fencing. Other programs include warm water fish production; Hot Creek Lake and Fish Hatchery; Brown Lakes winter fish kill prevention; Use of Closed Basin water for fish production; and Use of Sanchez for public fishing. Figure IV-5 indicates only those facilities or areas presently available for recreation, fish and wildlife use.

g. Colorado Division of Parks and Outdoor Recreation

The Division is conducting studies to locate and develop water-based recreation sites near the center of the San Luis Valley in the Alamosa area. A series of pond sites somewhere along the Rio Grande west of Alamosa is being considered. Such sites would provide for both recreational and environmental opportunities, including swimming, boating, sailing, fishing, trails, nature study, and habitat preservation. Existing sites are shown in figure IV-5 in conjunction with Division of Wildlife activities.

h. Colorado State Forest Service

Operating as a part of Colorado State University the state forester and his staff manage the forest resources of the state school lands under a cooperative agreement with the State Board of Land Commissioners. Another program offers technical assistance to private landowners who wish to manage their forest land for wood products or less tangible benefits or some combination thereof. Other activities include fire control, insect and disease detection and control, resource inventories, research youth programs, and the production and distribution of tree seedlings for conservation plantings.

i. Colorado Mined Land Reclamation Board

The Colorado Mined Land Reclamation Board initiates and encourages studies and programs through the department and in other agencies and institutions of state government. These studies and programs relate to the development of less destructive methods of mining operations, better methods of land reclamation, more effective reclaimed land use, and coordinating programs of other state agencies dealing with environmental, recreational, rehabilitation, and related concerns.

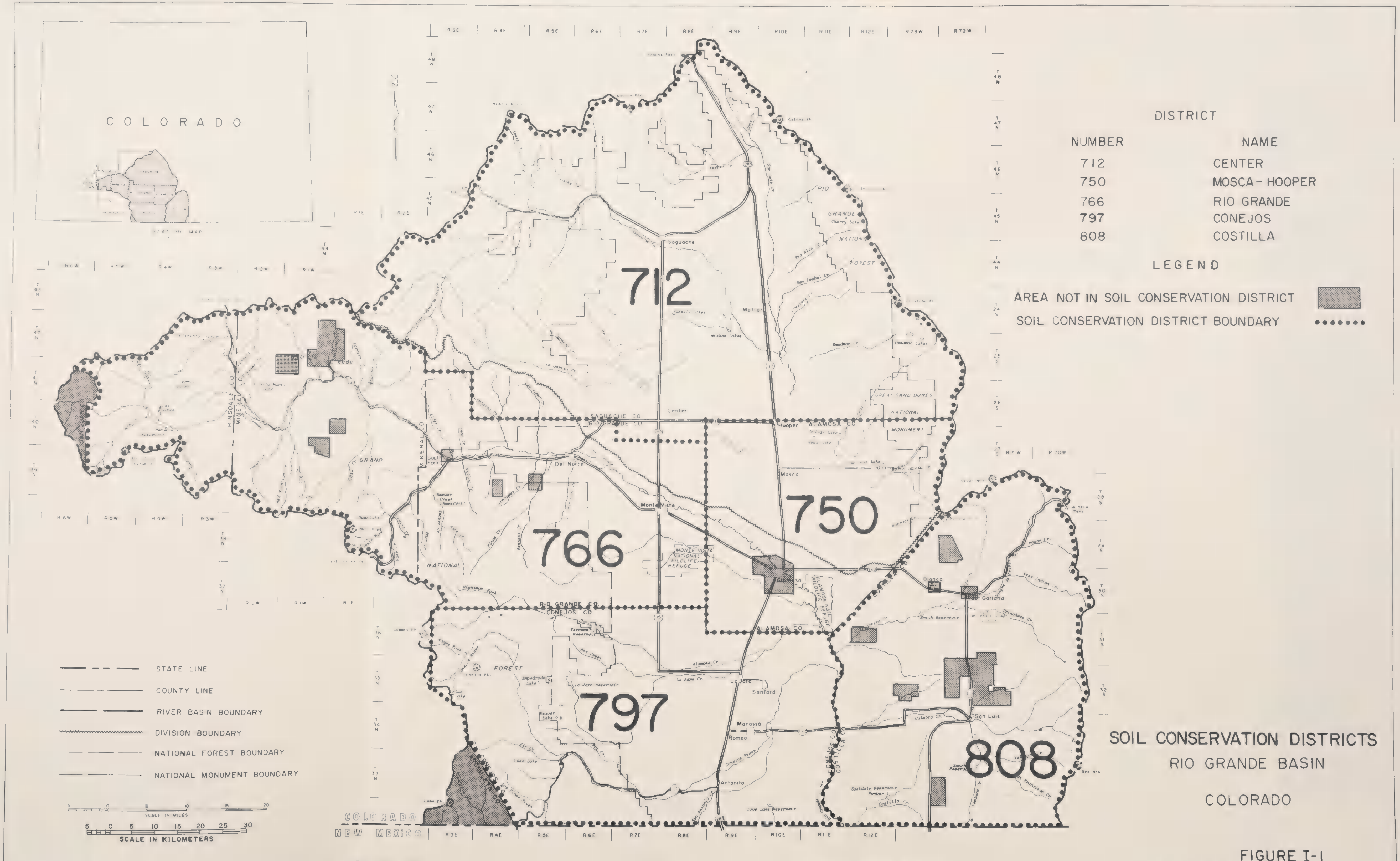
j. Four Corners Regional Commission

The Rio Grande Basin is entirely within the Four Corners Development Region, headed by Four Corners Regional Commission which was created by the Economic Development Administration, an agency within the Department of Commerce established by the Public Works and Economic Development Act (PL 89-136) of 1965 and amended by PL 90-103, 1967. The Commission's primary goal is to draw up plans and formulate programs to help stimulate the economic development of a 92-county area of Arizona, Colorado, New Mexico, and Utah. The Commission is presently: (1) evaluating the available resources of the area, (2) establishing development goals, and (3) preparing a program that will coordinate all public and private efforts for the best socioeconomic development and growth in the region. Proposals and project suggestions will be evaluated by the Commission and those with the most direct impact will be selected for initial action.

k. Soil Conservation Districts and Other Local Citizen Groups

Five Soil Conservation Districts (see figure I-1) have programs to promote conservation practices through cooperative agreements with farm and ranch operators. Through these agreements,

private landowners are furnished technical assistance by the Soil Conservation Service for instigating conservation practices. Upon request, assistance also is given to irrigation and drainage districts, recreation groups and rural communities. The U. S. Forest Service and the Bureau of Land Management also cooperate with the districts when public land is involved.



SOIL CONSERVATION DISTRICTS
RIO GRANDE BASIN
COLORADO

FIGURE I-1

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